Bob Gross

United States
Department of
Agriculture

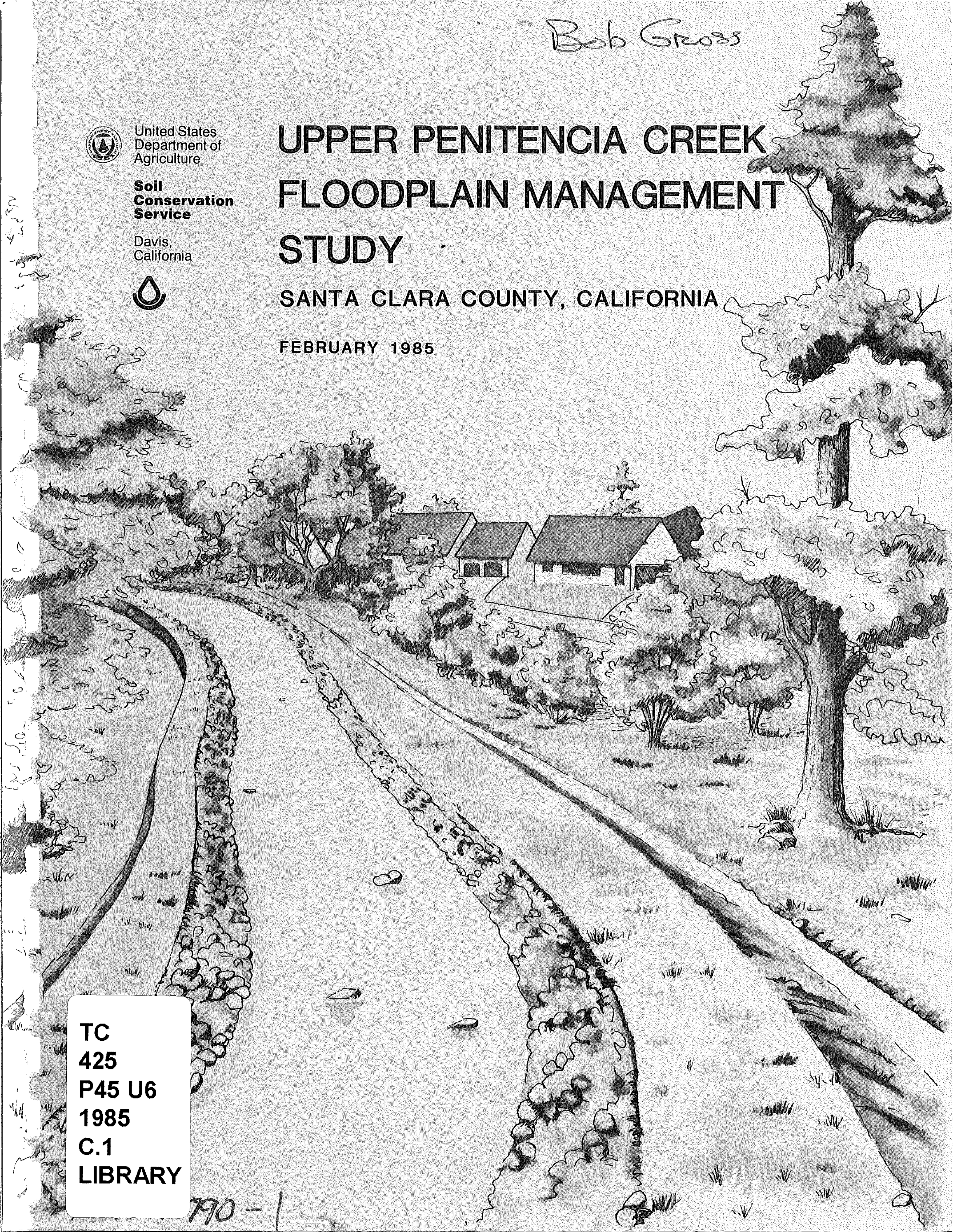
**Soil
Conservation
Service**

Davis,
California

UPPER PENITENCIA CREEK FLOODPLAIN MANAGEMENT STUDY

SANTA CLARA COUNTY, CALIFORNIA

FEBRUARY 1985



TC
425
P45 U6
1985
C.1
LIBRARY

790-1

PROPERTY OF SANTA CLARA VALLEY
WATER DISTRICT
5750 Almaden Expressway
San Jose, California 95118

2.1.790-1

TC425P45U61985c.1

Floodplain Management Study

UPPER PENITENCIA CREEK WATERSHED
SANTA CLARA COUNTY, CALIFORNIA

Sponsored by:

Evergreen Resource Conservation District
Santa Clara Valley Water District

Prepared by:

USDA Soil Conservation Service

March 1985

TABLE OF CONTENTS

PAGE
INTRODUCTION 1
Study authority and purpose 1

STUDY AREA DESCRIPTION 2

NATURAL VALUES 5

FLOOD PROBLEMS 7

PUBLIC PARTICIPATION AND COORDINATION 12

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT 14
Alternative One - No action 14
Impacts 15
Alternative Two - By-pass channel 15
Impacts 16

METHODS OF IMPLEMENTATION 20

INVESTIGATIONS AND ANALYSES 21
Hydrologic 21
Hydraulic 21
Biology 22
Engineering 22
Economics 23
Geology 23

GLOSSARY 25

APPENDIX A - Downstream impacts .29
APPENDIX B - Flood plain maps 31

UPPER PENITENCIA CREEK
FLOOD PLAIN MANAGEMENT STUDY

INTRODUCTION

The Upper Penitencia Creek Flood Plain Management Study was sponsored and conducted by the Santa Clara Valley Water District (SCVWD) and the Evergreen Resource Conservation District (ERCD), with assistance from the Soil Conservation Service (SCS). The Sponsors and SCS prepared a Plan of Work in December 1983 for the purpose of guiding the study. The Plan of Work listed major study items, including the study area, scope, responsibilities, estimated study costs, funding arrangements, type of report, and work item completion dates.

STUDY AUTHORITY AND PURPOSE

This study was conducted under authority of Public Law 83-566, Section 6, Flood Plain Management Assistance Program. This program allows the Soil Conservation Service to assist state and local governments in appraising water and land resources and formulating management options for conservation and use. Other authority comes in response to Recommendation 9(c) of the House Document No. 465, 89th Congress and Executive order 11988 dated May 24, 1977. The purpose of this study was to develop detailed flood data that can be used by local community leaders and city and county officials to reduce flood losses by improved management of the flood plain. Specific study objectives were to:

1. Prepare an inventory of natural resources.
2. Provide a listing of the environmental and social concerns of the residents in the watershed.
3. Prepare updated flood plain maps that can be used to improve implementation of building codes and flood plain management regulations.
4. Provide flood damage estimates for 5 different storm events.
5. Formulate alternatives for reducing flood damages and avoiding future flood damages.
6. Evaluate the impacts of the alternative solutions.
7. Gauge the acceptability of alternative solutions.

STUDY AREA DESCRIPTION

The Upper Penitencia Creek watershed study area (Figure 1), covers an area of about 24 square miles (15,300 acres). It lies within the California Water Resources Region and is in the San Francisco Bay subregion. Upper Penitencia Creek is located in the eastern portion of the city of San Jose and in the unincorporated area of the county of Santa Clara. San Jose is situated at the southern end of San Francisco Bay in the Santa Clara Valley.

The watershed can best be described by dividing it into 2 areas: the drainage area upstream of Dorel Avenue and the area downstream of Dorel Avenue. The upstream area contains about 21 square miles, is in the mountains, and is relatively undeveloped. Land use is predominantly range and brushland with woodland along the channels. This area is oblong in shape and is 10 miles long and 5 miles in width at its widest point. The remaining 3 square miles in the area downstream of Dorel Avenue are located on the valley floor and resemble a rectangular shape. This lower area is heavily urbanized. A detailed analysis was conducted on the 4 miles of stream contained in this area.

Upper Penitencia Creek extends for approximately 7 miles upstream of its confluence with Coyote Creek where it is joined by its major tributary, Arroyo Aguague. This major tributary continues for another 9 miles to the top of the watershed. Upper Penitencia Creek flows in a westerly direction from its tributary areas from an elevation of 2,600 feet MSL to an elevation of about 52 feet MSL at its confluence with Coyote Creek.

The area has a Mediterranean type climate consisting of moderate temperatures and light to moderate precipitation. Ninety percent of the rainfall occurs from November through March.

Temperature extremes range from about 20°F to 110°F. The average winter lows are in the middle 30s, while the summer highs average in the 80s. The growing season is about 336 days. Precipitation averages 14 inches in the Santa Clara Valley with up to 18 inches in the mountainous areas in the eastern part of the watershed.

Soils in the foothills above Dorel Avenue consist of residual soils weathered from rock and include the moderately well-drained clay loam soils of the Altamont-Azule association and the well-drained loam soils of the Los Gatos-Gaviota-Vallecitos association. Three groups of soils occur on the urbanized areas below Dorel Avenue. The Yolo loam and Garretson gravelly loam are well drained soils on alluvial plains and fans. These soils occupy about 5,200 acres with the Garretson restricted to stream benches along channels. The soils have slopes of 0 to 5 percent. The Cropley clay and Yolo silty clay loam are well-drained soils on alluvial plains on the edges of alluvial fans. These soils have slopes of 0-2 percent and occur on about 2,600 acres. The third group of soils lies in a north-south band east of Coyote Creek. It is comprised of Campbell silty clay and silty clay loam which are somewhat poorly drained soils on low valley bottoms and alluvial plains. They occupy about 2,300 acres and their slopes are 0 to 2 percent.

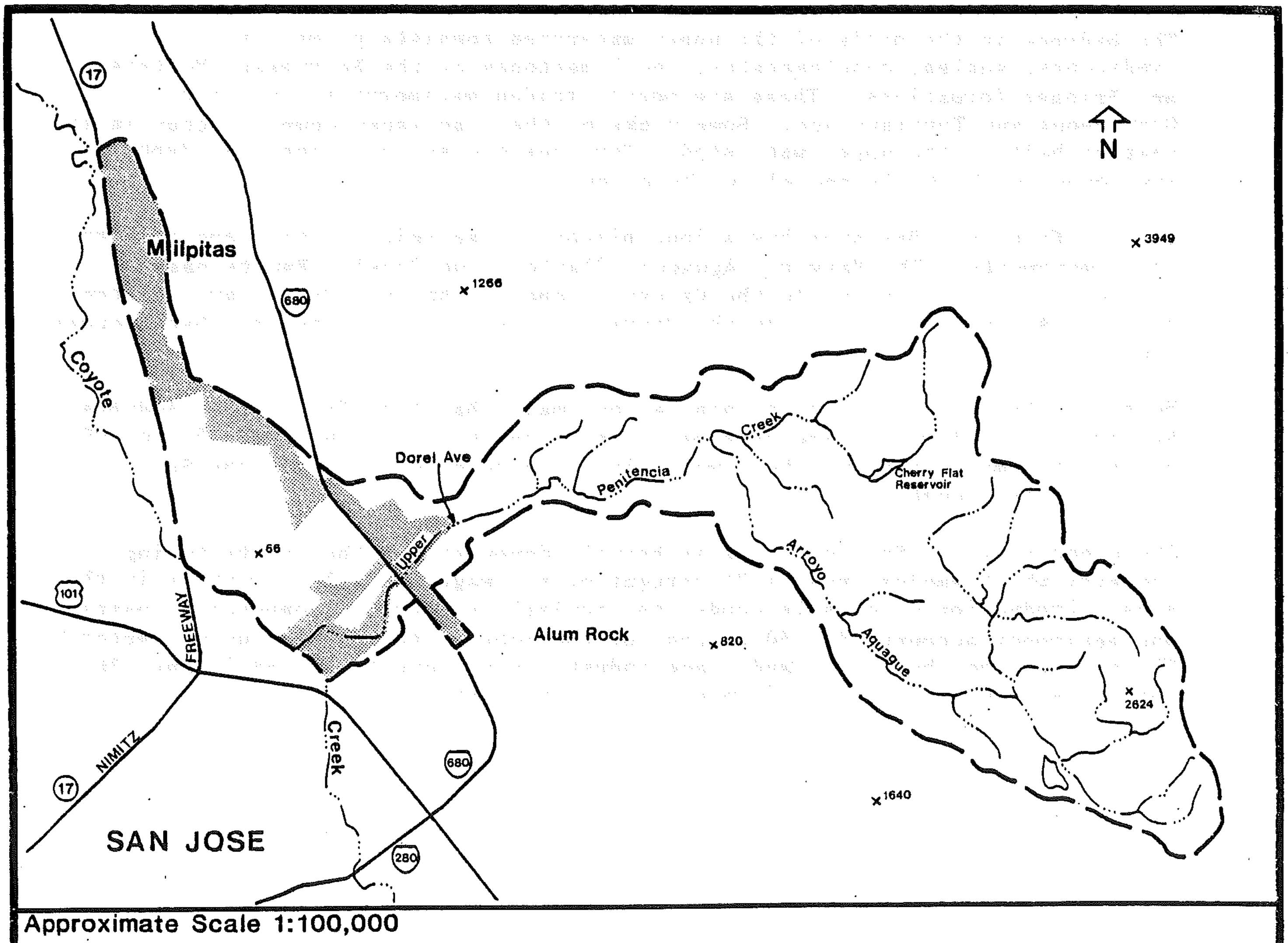
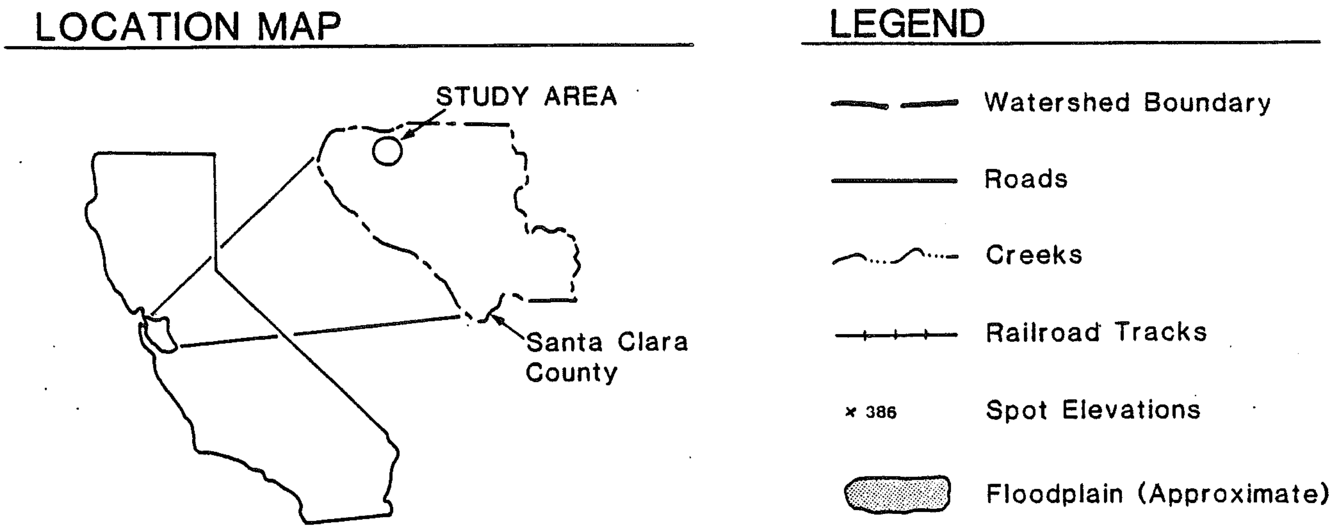

N
17
Milpitas
680
1266
3949
Coyote
Dorel Ave
Creek
Penitencia
Cherry Flat Reservoir
Upper
66
101
FREEWAY
Alum Rock
820
Arroyo
Aguague
2624
NIMITZ
17
Creek
680
1640
SAN JOSE
280
Approximate Scale 1:100,000

Figure 1


LOCATION MAP
STUDY AREA
Santa Clara County
LEGEND
Watershed Boundary
Roads
Creeks
Railroad Tracks
386
Spot Elevations
Floodplain (Approximate)

The bedrock in the hills of the upper watershed consists primarily of sandstones, shales, conglomerates, and limestones of the Berryessa, Monterey, and Briones formations. These are mostly folded metamorphosed units of Cretaceous and Tertiary age. Some rocks of the Franciscan complex occur in the eastern half of the upper watershed. Numerous old and new landslide deposits are found in the hills and along the creek.

The San Francisco Bay area has a long history of seismic activity and related earth movements. The Hayward, Aguague, Clayton, and Crosley Faults pass through the watershed, while the Calaveras and San Andreas Faults are located nearby. Active faults include the Hayward, Crosley, Calaveras, and San Andreas Faults.

Measurements of accumulated strains across major Bay Area faults (San Andreas, Hayward, and Calaveras) indicate major earthquakes will occur every 50 to 100 years. Maximum forces may be comparable to those experienced in the San Francisco earthquake of 1906.

The economy of the San Jose area is heavily dependent on the manufacturing industry which employs nearly 35 percent of all wage and salary workers in the area. Production of durable goods, particularly electronic components, parts, and equipment accounts for 50 percent of the jobs in the manufacturing sector. The service and the retail and trade industries account for an additional 30 percent and 20 percent of all wage and salary workers.

NATURAL VALUES

Upper Penitencia Creek begins in an oak-dominated upper watershed. Even with its close proximity to San Jose, this upper area is relatively undeveloped and supports many species of wildlife. Deer and mountain lions are known to reside in the mountain area. The lower five miles, through the urbanized area, have a good stand of riparian vegetation along both banks. This vegetation corridor is interrupted in only a few areas. The dominant trees are California sycamore, willow, Fremont cottonwood, coastal live oak, California buckeye, and Mexican blue elderberry. There are 40 acres of riparian vegetation/open water from Dorel Avenue to Coyote Creek.

The riparian vegetation supports a variety of bird species as well as several species of mammals, reptiles, and amphibians. The riparian corridor serves as a travel route for many animals, including those which disperse and migrate between the mountains and the valley floor. The vegetation connects with the riparian system along Coyote Creek and animals can move into and out of this area as well.

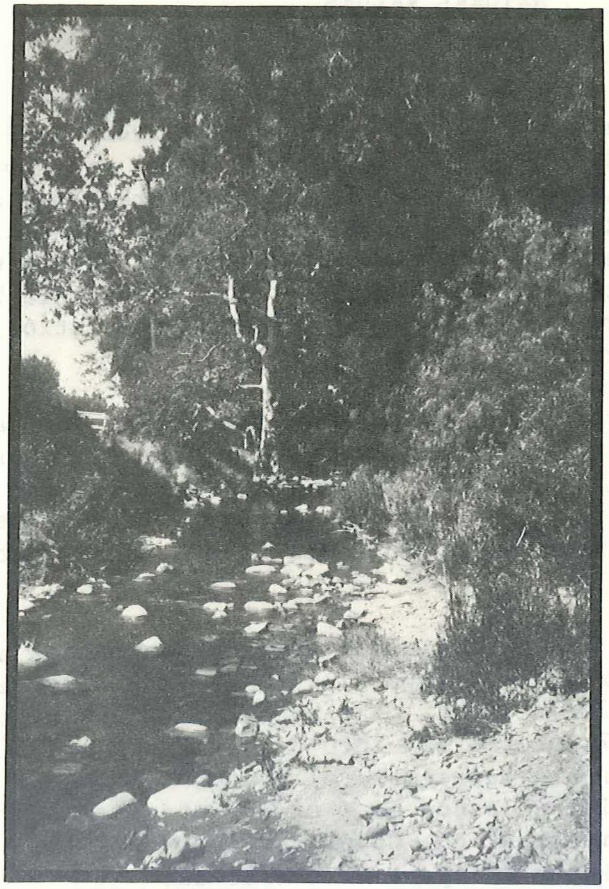
The riparian vegetation shades Upper Penitencia Creek and provides nutrients for the aquatic ecosystem. The waters support green sunfish, riffle sculpin, roach, rainbow trout, and steelhead trout. The steelhead trout migrate from the Pacific Ocean through San Francisco Bay into Coyote Creek and finally into Upper Penitencia Creek. They spawn between Dorel Avenue and the waterfall in Alum Rock Park. This is significant since most of the steelhead spawning habitat has been eliminated throughout the Coyote Creek watershed. Historically salmon were also known to spawn in the creek.

The creek is also a breeding area for Pacific treefrogs and western toads. The toads spend most of the year in the adjoining residential areas in yards and gardens. They eat insects which cause damage to ornamental and vegetable plants. During the late winter they migrate to the creek to breed and lay eggs. By early summer the tadpoles change into toads and move away from the creek.

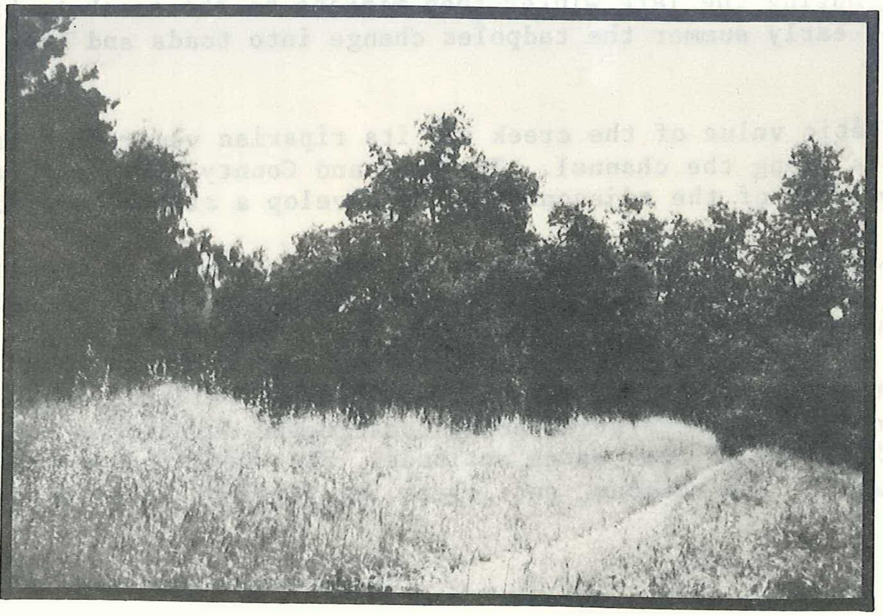
The aesthetic value of the creek and its riparian vegetation is recognized by landowners along the channel. The City and County parks departments have purchased much of the adjacent land to develop a stream corridor park.

The San Joaquin kit fox is a federally listed endangered species that has been observed adjacent to the watershed. A flood plain resident reported a possible kit fox sighting near Dorel Avenue.

Since the lower watershed is heavily developed, wetlands have long since disappeared. The percolation ponds constructed downstream of Toyon Avenue provide 10 acres of open water wetlands. Waterfowl and shorebirds regularly use the water, its margins, and levees for feeding, roosting, and cover.



Typical riparian vegetatior; Coastal Live Oak, California Sycamore and Mexican Elderberry.



FLOOD PROBLEMS

Historical Flooding

Perhaps the largest flood of the century occurred in 1911. No stream gauge data exists for that flood and, therefore, a frequency has never been assigned to that event. Although no damage estimates are available, the following excerpts were taken from a local newspaper article published on March 7, 1911:

> "Penitencia Creek had evidently overflowed its banks for its entire length between the mouth of Alum Rock Canyon and the Coyote Creek. At Capitol Avenue.... water stood three feet...."
>
> Two bridges in the canyon were carried away, a railroad bridge below the tunnel which went out sometime Sunday night and a railroad bridge.... was torn loose yesterday.

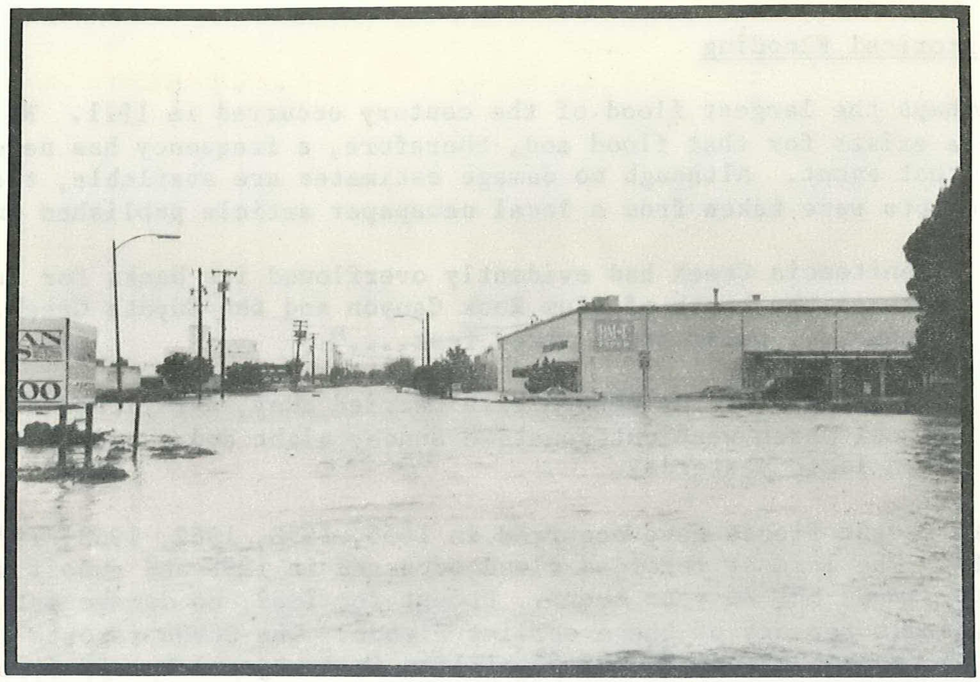
More recent floods have occurred in 1955, 1958, 1962, 1963, 1973, 1980, and 1982. The largest recorded flood occurred in 1958 and runoff was estimated to approximate the 25 year event. Except for 1982, no damage estimates are available for any of these earlier floods. The SCVWD reports that the 1982 flood caused between $1 and $2 million in damages. Runoff from this storm was estimated to approximate the 10 year event.

Potential Present and Future Flood Damages

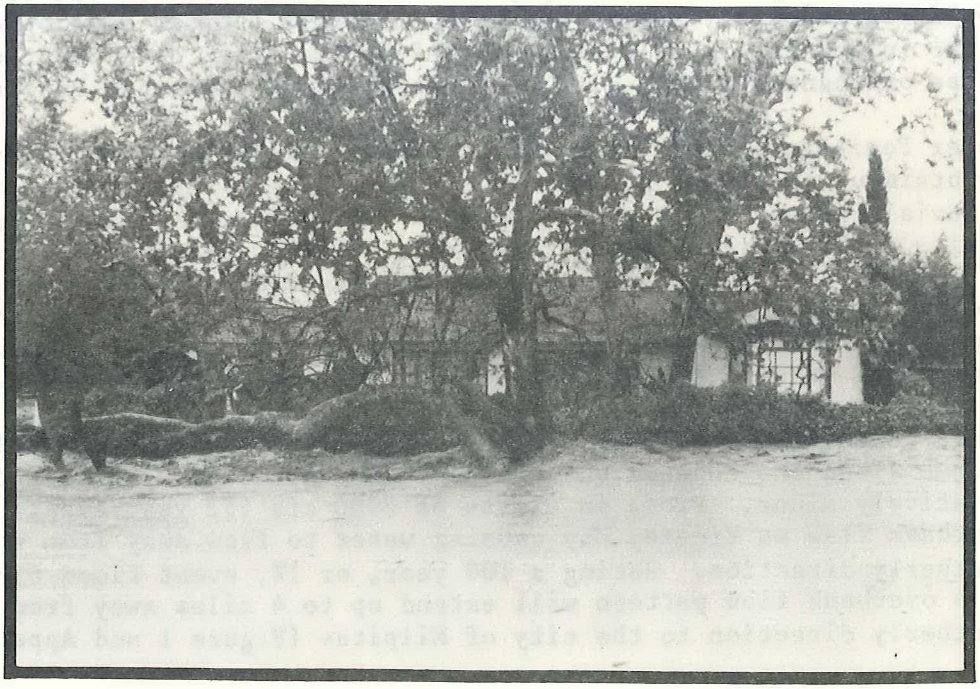
All floods up to and including the 500 year event were used to evaluate the potential damages under present land use conditions. Future flooding is projected to cause approximately the same damages as present conditions. No changes are expected in the physical characteristics of the watershed that would significantly affect the rate of runoff. Urban development that might occur in the future will be regulated by the local government ordinances. These ordinances comply with the Federal Flood Insurance Program.

Upper Penitencia Creek is a well defined, incised channel where it leaves the mountainous area near Dorel Avenue. However, as the stream flows over the alluvial fan and enters the urbanized valley floor, channel capacity becomes limited. Downstream from Viceroy Way, channel capacity declines from 2000 cfs to 500 cfs at a point just upstream of King Road. Storms producing runoff in excess of 500 cfs will cause overbank flow. The location of this overbank flow depends on the amount of water traveling in the channel. Higher amounts of water will cause overbank flow to occur at locations further upstream.

Flows between 500 and 1400 cfs will cause flooding west (downstream) of Capitol Avenue along the channel but the damages associated with this flooding will be relatively minor. Flows in excess of 2000 cfs (12 year event) will cause overbank flow at Viceroy Way causing water to flow away from the stream in a northerly direction. During a 100 year, or 1%, event flood flows following this overbank flow pattern will extend up to 4 miles away from the stream in a northerly direction to the city of Milpitas (Figure 1 and Appendix B).



Industrial flooding, photograph taken February 1982.



Floodwaters damaging houses and large trees, photograph taken February 1982.

During the 100 year event approximately 1850 acres will be inundated with up to 5 feet of water. In general, average depths will be about 2-3 feet but as the water ponds in the Milpitas area depths will approach the 5 foot level. Of the 4200 buildings located in this 100 year flood plain, 1300 will have water entering their first floors. Damages to these buildings and contents alone have been calculated to be $43.9 million. Five different storm frequencies were evaluated to determine damages to the buildings and their contents (Table A). Based on this analysis, it is estimated that average annual damages to buildings and contents will be $1,456,800.

TABLE A
FLOOD DAMAGES AND BUILDINGS FLOODED BY STORM EVENT

TYPE OF BUILDING	10yr	25yr	50yr	100yr	500yr
RESIDENTIAL					
Total Damages ($)	377,000	2,481,000	15,062,800	28,067,300	38,135,300
Number Flooded (#)	22	141	787	1146	1325
COMMERCIAL					
Total Damages ($)	1,505,200	2,017,300	6,957,200	11,450,100	15,890,000
Number Flooded (#)	13	52	114	115	129
INDUSTRIAL					
Total Damages ($)	0	2,787,100	3,801,300	4,397,000	9,310,800
Number Flooded (#)	8	13	17	41	45
TOTAL DAMAGES ($)	1,882,200	7,285,400	25,821,300	43,914,400	63,336,100
TOTAL FLOODED (#)	43	206	918	1302	1499

Several major roadways would also be severely affected by flooding. Stretches of Capitol Avenue, Trade Zone Boulevard, Montague Expressway, Old Oakland Road, Highway 17, Interstate 680, Calaveras Boulevard, King Road, and a number of smaller roads would be subject to closure because of flooding (Table B).

TABLE B
ROAD FLOODING BY STORM EVENT

LOCATION	10-YEAR		25-YEAR		100-YEAR	
	Depth (Ft.)	Duration (Hrs.)	Depth (Ft.)	Duration (Hrs.)	Depth (Ft.)	Duration (Hrs.)
I-680 at McKee [1/]	16	.5	30	2	30	4
Capitol Avenue at I-680	0	0	1	5	2	7
King Road between Maybury and Upper Penitencia Ck.	.7	16	.7	20	.7	24
Intersection of Trade Zone Blvd. and Montague Expwy.	0	0	.3	13	2	14
Old Oakland Road	0	0	0	0	1.4	7
Calaveras Boulevard	.5	10	.5	10	1.5	10
Highway 17	.5	10	.5	10	1.5	10

[1/] This is an underpass. Hours noted are estimates of time to pump water out of underpass.

Closure of these roads would cause major traffic disruptions and congestion. Traffic flows in many cases would be re-routed to flood-free areas causing motorists significant time delays and increased operating costs to arrive at their destinations. During the 100-year event, as many as 346,000 vehicle trips involving 484,000 people would be affected by these road closures. These people could be expected to have a 30-minute to one-hour delay in travel time and each vehicle could average about $1.00 in extra operating expenses. Average annual losses due to this traffic disruption are estimated to be $16,900.

Road closures would also affect emergency services. Police, fire, and medical vehicles could be delayed in responding to calls for assistance, thereby resulting in an increased threat to life and property.

In addition to traffic disruptions, sediment deposition would occur on many of the roadways, necessitating lengthy and expensive cleanup activities (Table C). In most areas, this sedimentation would be only minor (1 inch or less) during the 100-year event. However, in the low, ponded areas where sediment would have the opportunity to deposit, sediment depths could reach 3 to 4 inches. Average annual cleanup costs are estimated to be $34,300.

TABLE C
SEDIMENT DAMAGES TO MAJOR ROADS

FLOOD EVENT (Years)	SEDIMENT DEPOSITION (Tons)	(Cubic Yards)	CLEANUP COST
10	7,800	7,200	$ 266,400
50	10,200	9,400	347,800
100	15,700	14,400	532,800

Approximately 5,100 automobiles are owned by floodplain residents. If these vehicles are not removed from the floodplain before floodwaters rise, they will suffer damages. Nuisance damages would begin when floodwaters exceed 6 inches in depth and would increase substantially when the water reaches 12 inches and begins to enter vehicles. It is estimated that approximately 2,400 vehicles would receive some damage due to flooding during the 100 year event. Average annual damages to these vehicles are estimated to be $131,600.

In the event of a large flood, emergency services would be required in the floodplain. In the Upper Penitencia Creek floodplain, residents would require some form of emergency assistance for floods exceeding the 10 year event. The amount of emergency help required would increase as the severity of the flood event increases. For instance, at the 100 year event about 200 police, civil defense, and/or national guard personnel would be needed to secure the area against looting and assist in emergency operations. Buses, boats, and other vehicles would be needed to evacuate an estimated 2,500 people. Emergency shelters would have to be set up by relief agencies to feed and house the people evacuated. Medical help would also have to be made available. The average annual cost of providing these services is estimated to be $4,900.

The total value of average annual damages evaluated in all categories is estimated to be $1,644,500. However, in any densely populated floodplain such as Upper Penitencia Creek, a major flood would cause many other damages that were not evaluated in this study. Estimates are not made on structural damages that would occur to utilities, roads, and bridges. Estimates also are not made on revenues that would be lost by businesses in the commercial and industrial areas or on lost wages of employees of these businesses.

PUBLIC PARTICIPATION AND CONSULTATION

In June 1984 the Santa Clara Valley Water District mailed out over 7,000 letters to property owners and residents who lived in or near the flood plain. The purposes of this letter were to: 1) notify citizens that a study was just beginning, 2) establish a mailing list of interested people who wanted to be kept abreast of the study's progress, 3) solicit names of citizens willing to serve on a steering committee, and 4) obtain a list of concerns that people had relative to the creek and the proposed study. Three hundred twenty people responded to the mailout, asking to be placed on the mailing list. Over 40 people volunteered their services or nominated others to serve on the steering committee, and 85 people listed one or more concerns or suggestions with respect to the creek and the impending study. Below is a summary of concerns or suggestions received.

1.	Past flood history or current flood problems	21 responses
2.	Existing flood control measures and suggestions for measures that should be considered	19 responses
3.	Flood insurance	18 responses
4.	General concern over types of solutions	10 responses
5.	Specific environmental concerns, both within and near the existing channel	11 responses
6.	Management, operation, and maintenance	7 responses
7.	Urban development, within and outside of the flood plain	4 responses
8.	Taxes and property values	3 responses

On August 7, 1984, a letter was sent by SCS to all 40 citizens whose names were suggested for serving on the steering committee, indicating that a steering committee organizational meeting was going to be held on August 22, in the floodplain. Fourteen private citizens responded to this invitation and all fourteen were invited by the sponsors to serve on the committee.

On August 10, 1984, the Santa Clara Valley Water District sent five letters to local government agencies potentially interested in or affected by the study. The letter requested that a representative be appointed to serve on the steering committee. Four responses were received.

Four steering committee meetings were held from August 1984 through October 1984. In addition to the 18 people identified above, representatives from the sponsoring organizations and the SCS attended these meetings. At no meeting did the attendance fall below 75 percent. During these meetings SCS personnel, representing various disciplines, presented the methodologies used in their evaluations and the results of their studies.

SCS prepared and mailed out three progress reports on the study. The progress reports produced in September 1984, November 1984, and January 1985 were mailed to all 320 people on the mailing list. These reports summarized the findings and results of the technical studies as they were being completed. In addition, these reports informed the readers of the progress of the public participation program and dates of upcoming events.

Two coordination meetings were held in May and September 1984 between SCS, the sponsors, and the County Parks Department to develop acceptable solutions to the flooding problem that would be compatible with the Park Master Plan.

On November 14, SCS mailed a letter to all 320 people on the mailing list notifying them that a public meeting was planned for November 29. Two legal notices were published in local newspapers on November 26, announcing the public meetings.

On November 29, a 3-hour public meeting was held at the Piedmont Hills High School located in the watershed and close to the flood plain. In addition to representatives of the sponsoring agencies and the SCS, 35 people attended the meeting. An overview of the study was presented during the meeting. According to 22 questionnaires returned to SCS, 21 people indicated a project similar to Alternative 2 was needed. Three people suggested other alternatives that should be examined.

In January 1985, a summary of the public meeting minutes was mailed to all steering committee members and to all those who attended the public meeting.

On November 29, 1984, a representive from SCS met with members of the East Flood Control Zone Advisory Committee (EFCZAC) to discuss the progress of the flood plain management study. Information available on the proposed alternative was distributed to the members. The EFCZAC consists of interested citizens and appointed government representatives who oversee all flood control works in the East Flood Control Zone of the SCVWD.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

A key objective of this study was to investigate alternative solutions to the flooding problems described earlier. It was agreed early in the planning process that rather than develop a wide range of potential solutions, the majority of engineering planning time would be spent identifying, developing, and evaluating one or two alternatives that would offer the best opportunity to achieve economic and environmental acceptance.

The hydrologic, economic, biologic, and geologic technical studies, coupled with the concerns expressed during the public participation process, were used to identify acceptable alternatives. Alternatives that were discarded early because it appeared that they would not meet with economic and environmental acceptance included non-structural measures, off-channel floodwater retarding structures, and channelization of the existing creek.

The ongoing land treatment program of the ERCD/SCS is adequate to protect the upper watershed from sheet and rill erosion. Lack of access limits the number of wildfires occurring on the range and brushland. The major source of sediment in the watershed is from streambanks. This is due to streambank erosion and landslides in the banks. The steep topography and weak soils are the primary cause of erosion. Since this is geologic erosion, no plans were made during this stage of planning to treat the streambanks.

Floodwater retarding structures located in the upper watershed were given some consideration. Geologic studies indicated the close proximity of the Hayward fault and several other less active faults. The canyons where the sites are located are steep and relatively narrow. The soils on the canyon walls are also unstable. In order to provide the high level of protection and safety which would be required to reduce the potential flood damages, multiple dams of significant height and cost would be required. Therefore, at this level of planning, upstream flood water retarding structures were dropped from further consideration.

It appeared that a by-pass channel system offered the best opportunity to accomplish the objective of reducing flood damages and minimizing the environmental concerns expressed by the residents and identified by SCS technical studies. Several variations of a by-pass system were investigated. The one exhibiting the least cost is displayed as alternative 2 below.

ALTERNATIVE ONE--NO ACTION: This alternative assumes that no corrective structural modifications will be made to the Upper Penitencia Creek system. It does assume that the local governments (City of San Jose, City of Milpitas, and Santa Clara County) will continue to enforce the regulations of the Federal Flood Insurance Program, which they have enacted by ordinance. These regulations require, among other things, that the first floors of all new construction be built one foot above the 100-year flood elevation. This alternative also assumes that the City and County master plans, including such plan elements as transportation and parks, are adhered to in their present form.

IMPACTS: This alternative will prevent flood damages to new development but will do little to prevent flood damages to existing buildings located in the flood plain. Damages to these buildings will remain at the level expressed in the problem section of this report which were estimated at $1.46 million on an average annual basis. Costs to clean up sediment, provide emergency services, and to close and reroute traffic will continue to accrue. Automobiles caught in the area during a flood will continue to be damaged. Total average annual flood damages would remain at $1.64 million, as stated in the problem section.

ALTERNATIVE TWO--BY-PASS CHANNEL: This alternative contains the same assumptions regarding the continued implementation of local ordinances and master plans as contained in alternative one. In addition, this alternative calls for the construction of a by-pass channel from just below Dorel Avenue to a confluence with Coyote Creek to carry flood flows. Low flows would continue to travel through the existing creek. The by-pass channel would run parallel to the existing channel, except below King Road where the by-pass would continue directly west through the industrial park. (Figure 2)

Throughout its entire length the by-pass channel will be separated from the existing Upper Penitencia Creek, except at 2 locations: near Noble Avenue and between Capitol Avenue and I-680 where the stream and channel will merge. The channel sections represent 1600 feet out of a total channel length of 19,000 feet.

The following provides a brief description of the proposed alternative by construction reach:

Reach I (.41 miles)

-- .18 Miles of trapezoidal concrete channel
-- .04 Miles of covered rectangular concrete channel
-- .17 Miles of rectangular concrete channel
-- 1 Concrete grade stabilization structure
-- 1 Triple 12' x 9.5' box culvert at Western Pacific Railroad
-- 1 Triple 12' x 9.5' box culvert at King Road
-- Requires 3.66 acres of additional rights of way

Reach II (.92 miles)

-- .03 Miles rectangular concrete channel
-- .88 Miles of excavated earth channel with rock lined low-flow channel
--1.76 Miles of levees (both sides of .88 miles of channel)
-- 1 Concrete tri-level structure of Upper Penitencia Creek
-- Add double 12.5' x 11' and double 12' x 7' box culvert at Jackson Avenue
-- Maintain existing arched pipe culvert for Upper Penitencia Creek at Jackson Avenue
-- Requires no additional rights of way

Reach III (.43 miles)

-- .13 Miles of excavated earth channel with rock lined low-flow channel
-- .27 Miles of excavated earth channel with earthen low-flow channel
-- .8 Miles of levees (both sides of .4 miles of channel)

-- 1 Diversion structure .13 miles upstream from Jackson Avenue
-- Requires 1.5 acres additional rights of way

Reach IV (.58 miles)

-- .57 Miles of rock lined channel
-- .92 Miles of levees (both sides of .46 miles of channel)
-- 3 Concrete grade stabilization structures
-- 2 Grouted rock grade stabilizations in Upper Penitencia Creek
-- Remove 150' of Penitencia Creek Road
-- Requires .3 acres of additional rights of way

Reach V (.46 miles)

-- .22 Miles of excavated earth channel
-- .17 Miles of rock lined channel
-- .04 Miles trapezoidal concrete channel
-- .78 Miles of levee (both sides of .29 miles of channel)
-- Requires no additional rights of way

Reach VI (.53 miles)

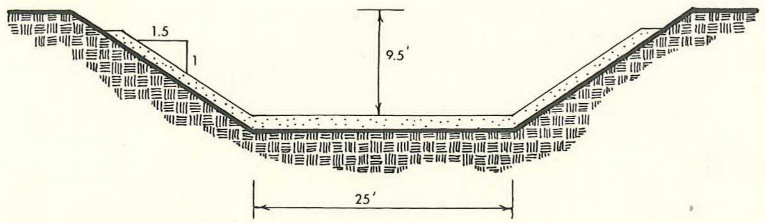
-- .25 Miles of trapezoidal concrete channel
-- .22 Miles of rock lined channel
-- .76 Miles of levee (both sides of .38 miles of channel)
-- 1 Concrete grade stabilization structure
-- Remove existing bridge at Noble Avenue
-- Install Triple 12' x 10.5' box culvert and diversion structure at Noble Avenue
-- Requires .7 acres of additional rights of way
-- Requires relocation of 1 house

Reach VII (.25 miles)

-- .25 Miles rock lined channel
-- .5 Miles of levee (both sides of .25 miles of channel)
-- 1 Concrete grade stabilization structure
-- 1 Grouted rock grade stabilization structure in Penitencia Creek
-- Install inlet structure and diversion
-- Remove Dorel Avenue bridge
-- Install triple 12' x 10.5' box culvert at Dorel Avenue
-- Requires no additional rights of way

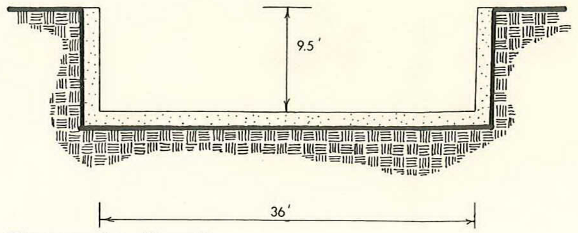
IMPACTS: This alternative would prevent flood damages to new development and reduce damages to existing facilities by 96 percent. Damages to buildings, contents and automobiles would be eliminated for all storms up to the 100 year event. Costs, in general, for sediment removal, emergency services, and transportation disruption would also be eliminated for storms up to the 100 year event. Table D illustrates the damage reduction benefits attributable to the alternative. The $63,200 in remaining damages (future with project) result from storms between the 100 and 500 year frequencies. Installation of this alternative would require the relocation of 1 house.

①



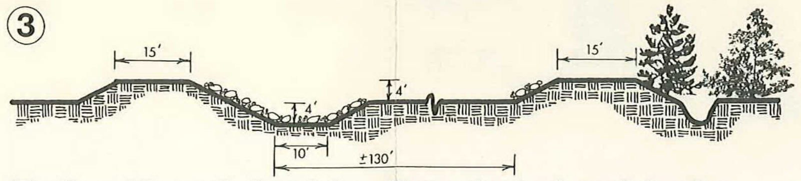
Concrete lined

②



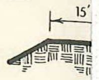
Concrete lined

③

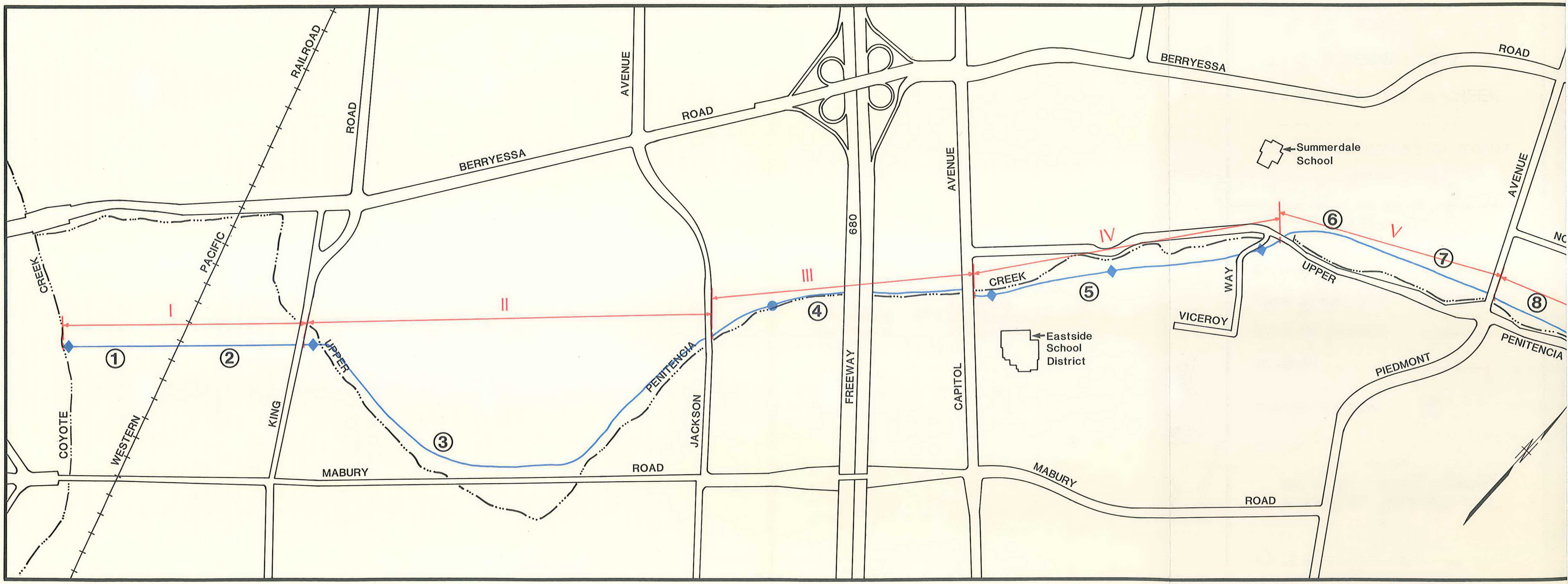


Earth with rock lined low flow channel and banks

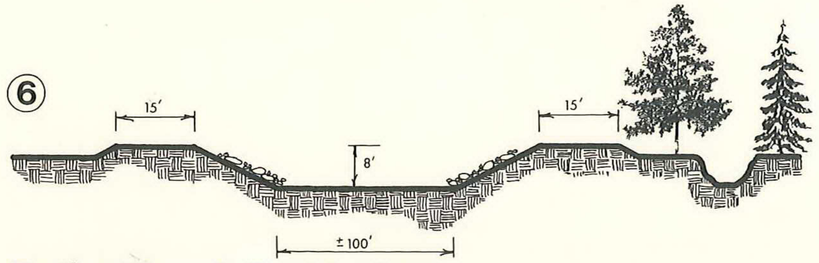
④



Earth

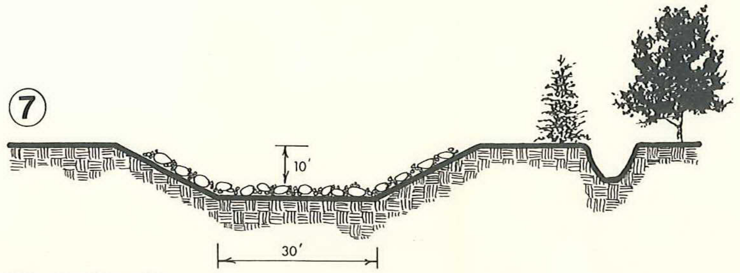


⑥



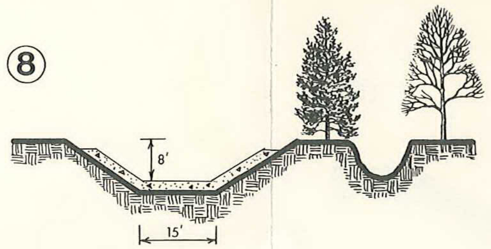
Earth with rock lined banks

⑦



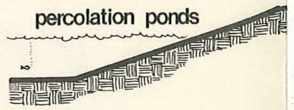
Rock lined

⑧

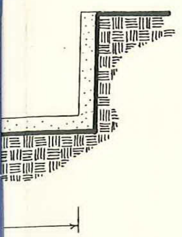


Concrete lined

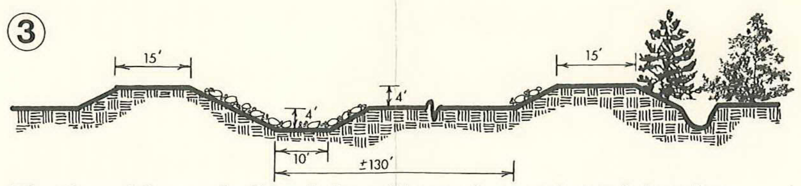
⑨



Rock lined

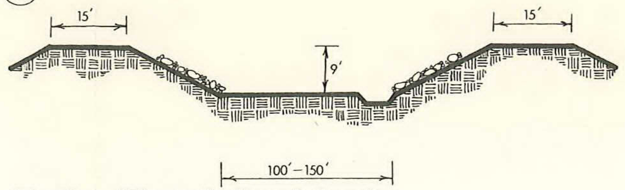


③



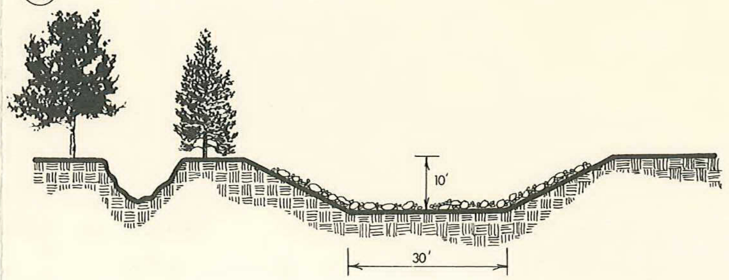
Earth with rock lined low flow channel and banks

④



Earth with rock lined banks

⑤



Rock lined

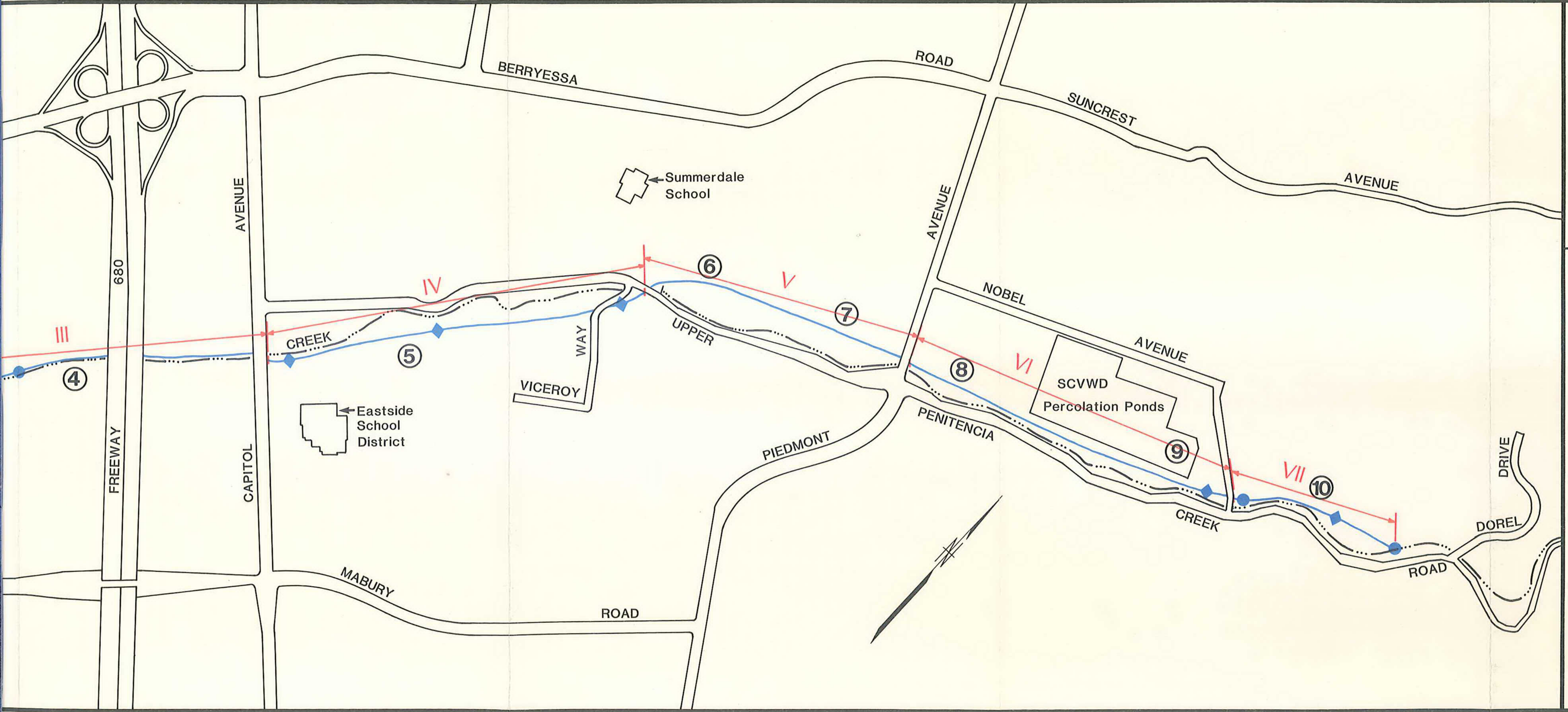


FIGURE 2

ALTERNATIVE 2

UPPER PENITENCIA CREEK

SANTA CLARA COUNTY, CALIFORNIA

FEBRUARY 1985

LEGEND

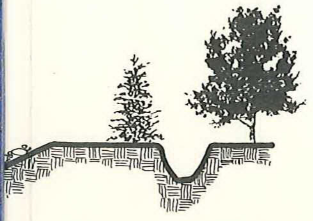
DIVERSIONS	● ● ●
DROP STRUCTURES	◆ ◆ ◆
BY-PASS CHANNEL	—
REACHES	IV
TYPICAL SECTION	②

SCALE:

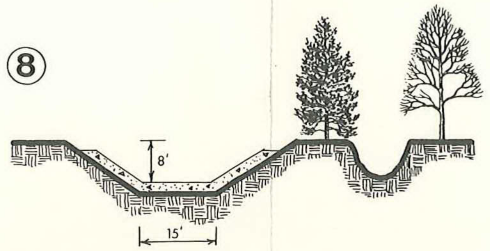
METERS
0 50 100 200 300 400 500 600

0 250 500 1000 1500 2000
FEET

SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

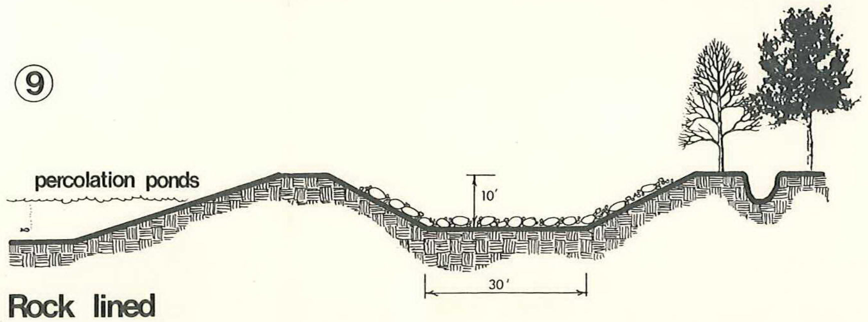


⑧



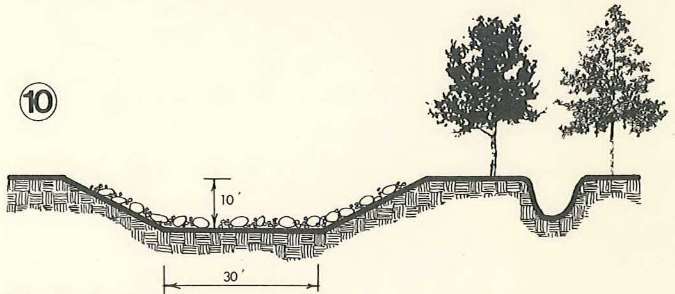
Concrete lined

⑨



Rock lined

⑩



Rock lined

APPENDIX A

APPENDIX B

TABLE D
DAMAGES AND BENEFITS
(Average Annual Values)

	FUTURE WITHOUT PROJECT	FUTURE WITH PROJECT	PROJECT BENEFITS
Residential, Commercial, and Industrial Buildings and Contents.	$ 1,456,800	$ 38,200	$ 1,418,600
Automobiles	131,600	19,900	111,700
Sediment	34,300	0	34,300
Emergency Services	4,900	600	4,300
Transportation Disruption	16,900	300	16,600
TOTALS	$ 1,644,500	$ 59,000	$ 1,585,500

In addition to the $1,585,500 in damage reduction benefits, $74,400 in benefits would accrue as savings in administering the national flood insurance program. Therefore, the total benefits attributable to this alternative are $1,659,900. Additional unevaluated benefits would accrue to floodplain residents in the form of a reduction of lost wages and business due to flooding and the elimination of the yearly flood insurance premium that residents currently pay as the 100 year flood plain would be virtually eliminated by this alternative.

The installation cost of this alternative is $13,340,800. If the project were to proceed as a watershed project under the PL-566 Small Watershed Program, the federal government would provide $10,321,700 with the local sponsors paying the remaining $3,019,100. Annual operation and maintenance costs, estimated at $41,400, would be paid with local funds. Using the current federal discount rate of 8 3/8 percent and amortizing these costs over a 100 year project life yields an average annual cost of $1,159,100. Comparing this cost to the average annual benefits of $1,659,900 produces a benefit cost ratio of 1.4:1.0. This means that for every $1 spent, this alternative would yield $1.40 in benefits.

From an environmental standpoint, installation of this alternative would cause the loss of 1.3 acres of mature riparian trees and the widening of 1600 feet of existing channel. These negative impacts would be offset by the planting of 3.0 acres of young riparian trees and planned enhancement of the steelhead and rainbow trout habitat in the existing channel. In addition, there would be an improvement in wildlife habitat on the 40 acres planned for the by-pass channel.

This alternative's impacts on downstream areas, along Coyote Creek and San Francisco Bay, were also investigated. Concerns that were evaluated included water quality, sediment, fresh water influxes, and induced flooding. Results of these analyses indicated that downstream impacts were insignificant. A more thorough discussion appears in Appendix A.

METHODS OF IMPLEMENTATION

The sponsors have an application pending with the SCS to pursue the development of a work plan and environmental impact statement under the PL-566 Small Watershed Program. This program permits the SCS to provide both technical and financial assistance to develop and implement a plan for flood control. The SCS is requesting permission from its National Office headquarters in Washington, D.C. to proceed with planning. Should this permission be granted, additional alternatives, including those that were suggested at the public meeting, will be developed and analyzed. The public participation process will be reopened to agencies and the general public at that time.

Should permission to proceed under PL-566 be denied, the sponsors should seek federal assistance from other sources. One such source is the U.S. Army Corps of Engineers under one of their applicable flood control programs.

Another option is to fund all of the final planning and construction with local funds. Currently the sponsors do not have the funds available that would be neccesary to install a structural project that would reduce the flooding potential to an acceptable level. However, as funds do become available the sponsors may consider proceeding with the project in increments. For instance, if the sponsors desired to install Alternative Two, the first available funds should be spent on obtaining the necessary land rights beyond those contained in the County Park Master Plan for Upper Penitencia Creek. The sponsors should also continue to support the land rights acquisition program of the Parks Department with respect to the Master Plan. Studies to date indicate that the availability and cost of these land rights could be a major problem and carry a significant cost in the future. The second area that should receive attention is the road and bridge crossings downstream of Capitol Avenue. Information developed as a part of this study indicates which crossings are inadequate. Therefore, as these crossings are replaced under the ongoing public works programs, consideration should be given to their proper sizing. It should be noted that enlarging these crossings will not necessarily reduce damages. More importantly, changing the sizes of the crossings upstream of Capitol Avenue will not only fail to reduce damages but could shift the flooding pattern to an area that is currently flood free. The next phase would involve using local money to build the by-pass channel beginning at the downstream end.

INVESTIGATIONS AND ANALYSES

Hydrologic

Hydrologic analyses were done to establish the peak discharge frequency for floods on Upper Penitencia Creek watershed for the 10, 25, 50, 100 and 500 year events.

The contributing drainage areas were broken down into smaller subbasins. The TR20 computer program was used with the storm distribution type IA and 24-hour precipitation values from NOAA Atlas 2 maps were inputted to produce hydrographs for each subarea. For Upper Penitencia Creek, the hydrographs were adjusted to reflect the peak flow rate and 24 hour volume as predicted by the SCVWD regional regression equations and LPIII analyses. A study was performed to see if the LPIII skew used could be predicted from the surrounding gauge skews. No regional skew could be determined from the study. Therefore, the accepted SCVWD skew of .6 was used in this analysis. Frequency results from the analysis of streamflow records at the Upper Penitencia Creek gauge did not match the results predicted using the regional regression equations. A weighting procedure was used to develop the discharges. For urban areas, the hydrographs were based on curve numbers and times of concentration using standard SCS procedures. Storage in the streets was accounted for by routing the urban area runoff through the urban storage, as developed by SCVWD.

The flow-frequencies calculated for Upper Penitencia Creek were:

Recurrence Interval (Years)	Peak Flow (cfs)	48-hr Volume (ac-ft)
500	6100	4210
100	4300	3100
50	3500	2400
10	1850	1260

Hydraulic

Flood elevations were computed using the U.S. Army Corps of Engineers' (COE) HEC2 water surface profile program. In the floodplain the HEC2 program was used to calculate rating tables along with normal depth calculation using Manning's Equation.

Channel cross section information was obtained from data developed by Nolte and Associates for the Flood Insurance Study for the Upper Penitencia Creek Channel and other channels in the study area. The cross section information for the Upper Penitencia Creek floodway was obtained from SCVWD. Some supplemental field survey work was done by the SCS. In the overflow area, cross section data was measured directly from the 2-foot topographic maps supplied by SCVWD. The flow was manually traced through the urban area to determine the depth and extent of the floodplain. No blockages were assumed to take place. Such blockages, should they occur, could alter the area flooded from that shown on the maps contained in this report.

Biologic

The riparian vegetation along Upper Penitencia Creek was mapped in April 1984. Aerial photos and field surveys were used to delineate the vegetated areas.

An SCS biologist and a California Department of Fish and Game (CDF&G) fisheries biologist used an electroshocker to determine fish diversity within the creek. This information was combined with a 1975 CDF&G survey to produce a species list.

An SCS biologist and U.S. Forest Service ecologist conducted a stream benthic insect survey in August 1984. The number of species and individuals were used to calculate a Shannon-Weaver Diversity index for the creek.

The U.S. Fish and Wildlife Service was contacted to determine any threatened and/or endangered species that may occur within the project area.

Engineering

Major constraints to the engineering design included the following: 1) the minimization of disruption to Upper Penitencia Creek, 2) the prevalence of erosive soils in the project area, 3) the relatively steep floodplain slope, and 4) the high rights-of-way costs. Additional rights-of-way required for the project assumed that Santa Clara County Parks Department would acquire all rights-of-way necessary for its Master Plan.

Two storm events, 10 year and 100 year, were analyzed. Water surface profiles using the COE's HEC2 program were developed based on the Coyote Creek water surface elevations derived from material supplied by SCVWD. Channel stability was checked using SCS-TR25. Because most of the soils encountered were unstable for the design parameters, rock or concrete linings are proposed. Concrete linings would be limited to those areas of restricted rights-of-way in reaches 1 and 6. Either rock lining or bank riprap would be used in all other areas of construction. In the reaches that would not be totally rock lined (reaches 2, 4 and 5) scour was anticipated. An analysis of the extent of this scour was not done for this phase of planning but should be analyzed during the next stage of planning.

Grade stabilization structures would be used at seven locations. The California Folded Weir design was thought to be the best type to fit the conditions of channel size and flow. Box culverts are proposed at the railroad crossing and at all road crossings. A tri-level crossing of the creek and the proposed channel was designed upstream of King Road. This was done to maintain the integrity of the creek for fish migration. Alternatives to this crossing should be explored during the next phase of planning. In two areas the creek and the proposed channel would be merged maintaining the riparian habitat on the south bank. Downstream from each of these areas and at the inlet to the project, diversions would be installed. They would divert normal stream flows to Upper Penitencia Creek and would limit flood flows to the bank full capacity (400 cfs) of the natural stream.

Construction cost estimates were made using unit costs derived from similar projects in the area. A 15 percent contingency was added to these estimates. Operation and maintenance costs were based on unit costs supplied by SCVWD and on other similar projects in the area. Engineering and administration costs were calculated based on time estimates needed to perform the tasks. These estimates, provided by the Design and Administrative Services staffs from the SCS State Office, were prorated to each reach based on the construction cost. Construction supervision was estimated to be 6 percent of the construction. All unit costs were reviewed by the SCS State Construction Engineer. Wildlife and visual mitigation were estimated as lump sum costs. The exact location of the required mitigation should be determined during the next phase of planning.

Economics

The economic investigation began with a complete inventory of all 4200 buildings in the floodplain. The inventory included location references, structure construction type, and structure value. Structure damage schedules were developed from this information and from interviews with a construction contractor.

More than 300 flood damage interviews were conducted with operators of flood plain businesses and residents to determine content damage schedules. The results of the interviews were analyzed using standard statistical techniques to determine the adequacy of the sample size and to verify that the flood plain damage schedules were consistent with national aggregates.

First floor elevations for more than 1,000 buildings were surveyed, including all commercial and industrial buildings and a sample of residences. This information, along with the economic information about each building and the hydrologic data was entered into the URBI Urban Floodwater Damage Evaluation Program.

Damages were calculated for 5 different storm events and the average annual damage determined.

Damages to automobiles were calculated in much the same manner as damage to buildings except an allowance was made for some cars to escape before floodwaters arrived.

Damage to roads and streets, disruption of transportation, and costs of flood related emergency services were calculated using information provided by local agencies.

A cursury evaluation of a non-structural solution was made using data developed for the adjacent Lower Silver Creek Watershed. A PL-566 study was just completed on that watershed two years ago. Based on that data a non-structural solution for the Upper Penitencia Creek was found to be not feasible.

Geology

A) Erosion and Sedimentation

Average annual sheet and rill erosion was estimated by a geologist using the Universal Soil Loss Equation. Calculations were made at sample points observed in the field. Samples were representative of the major soil, slopes, and cover combinations in the watershed. The sample data was expanded over the entire watershed. Flaxman's slope continuity procedure was used to estimate a sediment delivery ratio for the sheet and rill erosion.

The U.S. Forest Service estimates that about 10 percent of the upper watershed could burn every four years. Erosion rates will increase 10 to 15 times after the fire but the rates will return within another four years. Erosion and sediment from wildfires is included in the future without project scenerio. Erosion from rangeland was reduced 10 percent to reflect future land treatment measures applied under the ongoing ERCD/SCS program.

The erosion was multiplied by the sediment delivery ratio to get the average annual sediment yield from sheet and rill erosion. These procedures are outlined in SCS Technical Release 51 (1977) and in SCS National Engineering Handbook Section 3 (1984).

Sediment yield from sheet and rill erosion by storm frequency was determined using the Modified Universal Soil Loss Equation. This procedure is outlined in SCS Geology Note 2 (1980). The equation predicts the yield of fine-grained sediment only or the sediment moved in suspension. The grain size distribution of soils in the watershed and the acres of each soil occuring was used to estimate the grain size distribution of sediment in the watershed. The amount of coarse material moved was estimated by dividing the amount of fines by their percentage of total sediment to get the total amount of sediment. This total was multiplied by the percent of coarse material to get the amount of coarse material moved.

Direct volume methods outlined in instructions for the SCS Land Inventory Monitoring, Phase II erosion inventory (1978) were used to estimate erosion from eroding streambanks. Sample reaches of the channel were walked to estimate total bank erosion. Few gullies were observed in the watershed during field trips so no separate inventory of gully erosion was made. Roadbank and landslide erosion was estimated using the direct volume method. Higher sediment delivery ratios were used for generating sediment yield from these sources than were used for estimating sediment yield from sheet and rill erosion. Sediment yield by storm frequency from sources other than sheet and rill erosion was determined by multiplying the average annual sediment yield by the ratio between the volume of storm runoff and average annual runoff.

An electronic spreadsheet program for microcomputers was used to route sediment from the canyon mouth at Alum Rock Park entrance (Dorel Avenue vicinity) through the floodplain to Coyote Creek. Estimates were made of the sediment deposited in the channel and on the floodplain depending on the velocity of flow and the volume of water getting out of the channel. Sediment deposition in feet and acres was determined for the economist in order to develop sediment damages by flood frequency. Sediment reaching Coyote Creek under present, future with project, and future without project conditions was used to analyze downstream impacts. Data from other studies in the area were used to analyze the cumulative downstream sediment impacts of all flood control projects on Coyote Creek and its tributaries.

B) Channel Investigation

A soils investigation along the proposed channel alignment was done by contract. SCS geologists located 17 test holes, logged the soil profiles, and guided the collection of soil samples and the tests performed. A geologic report was written and used by the planning engineer for design. Existing soil survey reports and Bay Area geology reports were reviewed for supplemental information on soils, earthquake and landslide hazards, groundwater recharge facilities, and water quality.

GLOSSARY

ANNUAL COSTS - The amount of money needed to repay the initial construction cost in equal yearly installments, plus the yearly expenditure for upkeep of the project.

BENEFIT/COST RATIO (B/C RATIO) - The ratio obtained when the annual cost of the project is divided into its annual dollar benefits. PL-566 requires that the ratio be greater than 1 to 1.

CFS - Abbreviation for cubic feet per second. The rate of discharge or flow of water representing a volume of 1 cubic foot passing a given point during 1 second. One cubic foot per second is equivalent to approximately 7.5 gallons per second.

CHANNEL - A natural or artificially created open conduit that periodically or continuously conveys water. River, creek, stream, branch, and tributary are some of the terms used to describe channels.

CROSS SECTION (STREAM OR VALLEY) - The shape of a channel, stream, or valley viewed across the axis. In watershed investigations it is determined by a line approximately perpendicular to the main path of water flow, along which measurements of distance and elevation are taken to define the cross-sectional area.

DISCHARGE - The rate of flow or volume per unit of time. Usually expressed in cubic feet per second.

DRAINAGE AREA - The area, measured in a horizontal plane, which drains into a stream at a specified location. See watershed.

EROSION - The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

FLOOD - An overflow or inundation of normally dry lands from a stream or other body of water; the high streamflow overtopping the banks of a stream; or a high flow as measured by either stage or discharge.

FLOOD FREQUENCY (STORM EVENT) - The average interval of time between floods equal to or greater than a specified discharge or stage. It is generally expressed in years. Following are examples:

> 10-year flood or 10-year frequency flood. The flood which can be expected or exceeded on an average once in 10 years; and which would have a 10 percent chance of being equal or exceeded in any given year.
>
> 50-year flood...two percent chance...in any given year.
>
> 100-year flood...one percent chance...in any given year.
>
> 500-year flood...two tenths percent chance...in any given year.

FLOOD PEAK OR PEAK DISCHARGE - The highest value of the stage or discharge attained, thus, peak stage or peak discharge.

FLOODPLAIN OR FLOOD-PRONE AREA - The land area situated on either side of a channel or body of water which is subject to flooding.

FLOODPLAIN MANAGEMENT - The operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works, and land use and control measures.

FLOOD ROUTING -Determining the changes in a flood wave as it moves downstream through a valley or through a reservoir (then sometimes called reservoir routing.) Graphic or numerical methods are use.

GRADE STABILIZATION STRUCTURE - A structure in a channel bottom through which water flows from a higher elevation to a lower elevation without causing erosion.

HYDRAULICS - General--the science that treats water in motion. For this report--the determination of the depth and velocity of various discharges at given cross sections. Also hydraulic analysis.

HYDROLOGY - General--the science that deals with the occurrence and behavior of water in the atmosphere on the ground and underground. For this report--the determination of rainfall, runoff, and the resulting peak rate of discharge from a given drainage area for various frequencies. Also hydrologic analysis.

OVERLAND FLOW (SHEET FLOW) - Runoff which flows over the ground surface in a shallow layer--as opposed to channelized runoff.

PEAK DISCHARGE - The highest discharge or rate of flow during a flood at a given point.

PROFILE - A graph or plot of the water surface elevation against distance along a channel. Also termed "flood profile" if drawn for a specific flood or level of flooding.

REACH - A length of stream or valley selected for convenience in a study.

RIPARIAN VEGETATION - Vegetation which occurs along the banks of a stream, and which is influenced in species composition by flood frequency and water table.

RUNOFF - That portion of the precipitation on a drainage area that is discharged from the area in stream channels. Types include surface runoff, ground water runoff, or seepage.

SEDIMENT - Solid material, both mineral and organic, that is in suspension, and is being transported, or has been moved from its site of origin by air, water gravity, or ice, and has come to rest on the earth's surface.

STRUCTURAL MEASURES - Works of improvement for the purpose of providing flood prevention by the exclusion of floodwater from the flood plain. Structural measures include, but are not limited to (1) floodwater retarding dams, (2) channel work, (3) dikes, (4) debris and sediment basins, (5) floodways, and (6) floodwater diversions.

SUBAREA - A part of larger watershed having its own watershed boundaries within or coincident to the main watershed.

WATERSHED - The area contributing direct runoff to a stream. Usually it is assumed that base flow in the stream also comes from the same area. However, the ground water watershed may be larger or smaller.

WETLAND - An area where saturation with water is the dominant factor determing the nature of soil development and the types of plant and animal communities present; generally includes swamps, marshes, bogs, shallow lakes, and similar areas.

APPENDIX A
DOWNSTREAM IMPACTS

Introduction

As part of the environmental evaluation, SCS looked at the potential cumulative impacts of this project and other Federal, State and local projects upon downstream resources. This project will empty into Coyote Creek which flows into the south San Francisco Bay National Wildlife Refuge. Consequently SCS addressed the impacts to fish and wildlife along with downstream flooding.

The evaluation of cumulative downstream impacts considered the following four proposed flood control projects: Upper Penitencia, Lower Silver, Berryessa, and Coyote Creeks. Upper Penitencia, Lower Silver, and Berryessa Creeks are all tributaries to Coyote Creek.

Flooding

The proposed Coyote Creek project is designed to take increased flows resulting from channel improvements on Upper Penitencia Creek, Lower Silver Creek, and Berryessa Creek. It will handle the flows from the 100 year storm for all of these creeks (14,500 cfs). The increased flows from all the proposed flood control projects would be contained within the Coyote Creek channel and would not cause induced flooding downstream.

Fresh Water

Presently some flood waters from Upper Penitencia Creek flow overland and pond adjacent to the Nimitz freeway. This ponded water then takes up to a week to drain into Lower Penitencia Creek and reach the south San Francisco Bay. This ponded water is about 400 acre feet or 2 percent of the Coyote Creek flow during a 100 year storm.

The Upper Penitencia Creek project would contain the 400 acre feet of water within the by-pass channel and deliver the water to San Francisco Bay within one or two days instead of a week. This means there will be a greater concentration of fresh water reaching the mouth of Coyote Creek in a shorter period of time.

The other flood control projects would not increase the volume of freshwater reaching south San Francisco Bay but would shorten the delivery by one or two hours. The cumulative changes of freshwater volume and delivery duration would be very small.

The confluence of Coyote Creek and San Francisco Bay is a brackish water environment. This is due to both the freshwater inflows of Coyote Creek and the effluent of the San Jose Sewage Treatment Plant mixing with the salt water in the Bay. Animals that are adapted to this gradation of salinity concentrations would not be adversely impacted by the 2 percent increase of freshwater reaching the area during a 100 year storm.

Sediment

Today the sediment yield to Coyote Creek below Anderson Reservoir is 146,400 tons per year. On an average annual basis, about 9,500 tons of this sediment deposits on the Coyote Creek floodplain. The remaining 136,900 tons deposit in San Francisco Bay.

By 1995 all four flood control projects are scheduled to be installed. Channel modifications to Lower Silver Creek will increase the amount of sediment reaching Coyote Creek. The flood control work planned for Berryessa Creek will decrease the sediment delivery to Coyote Creek because it includes two debris basins. The wide and flat overflow channels planned for Coyote Creek will "catch" 36,000 tons of sediment on an average annual basis. The net result of these three projects is a decrease of 31,200 tons of sediment reaching the Bay on an average annual basis. Therefore the future average annual sediment delivery to the Bay from Coyote Creek will be 105,700 tons.

When the Upper Penitencia Creek project is installed the sediment that usually deposits on the Upper Penitencia Creek floodplain will be transported to Coyote Creek. The amount of sediment reaching San Francisco Bay will increase from the predicted 105,700 tons per year to 107,100 tons per year. This 1.3 percent increase in sediment delivered to San Francisco Bay will not adversely impact the Bay environment.

The net cumulative impact will be a 21.7 percent reduction in sediment delivered to the Bay (from existing conditions).

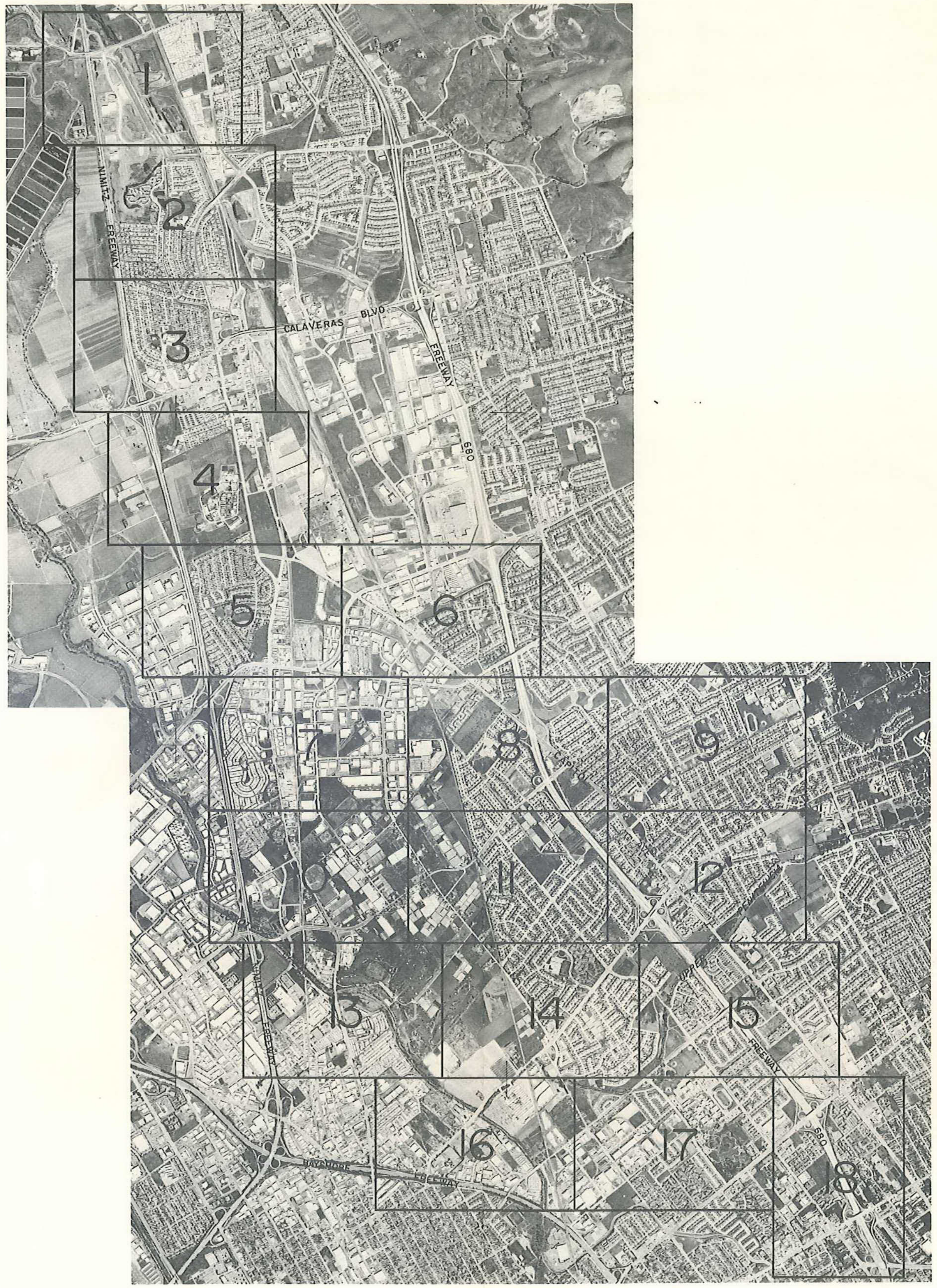
Water Quality

Street runoff in urban areas causes water pollution. Little change in water quality is expected as there will still be street runoff with the Upper Penitencia Creek project installed. However, pollutants picked up by ponded floodwaters will be reduced with the project because of reduced flooding. Cumulative impacts also will be reduced.

FLOODPLAIN MAPS

The following maps depict the potentially flooded areas caused by overflows from the Upper Penitencia Creek. The 10, 100, and 500-year events have been mapped. It should be noted that these maps do not include any flood flow from Berryessa Creek or its tributaries, as this study assumes that Berryessa Creek flows would be contained within bank as a result of the installation of the proposed U.S. Army Corps' of Engineers project on Berryessa Creek. Reference should be made to page 20 of this report for other hydrologic and hydraulic assumptions that were made as a part of this study.

As a part of this study, the SCS has supplied larger scale floodplain maps to the SCVWD. Contact the SCVWD should you require this type of detail.



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 500 1000 2000 3000 5000 7000
0 250 500 1000 1500 2000
METERS

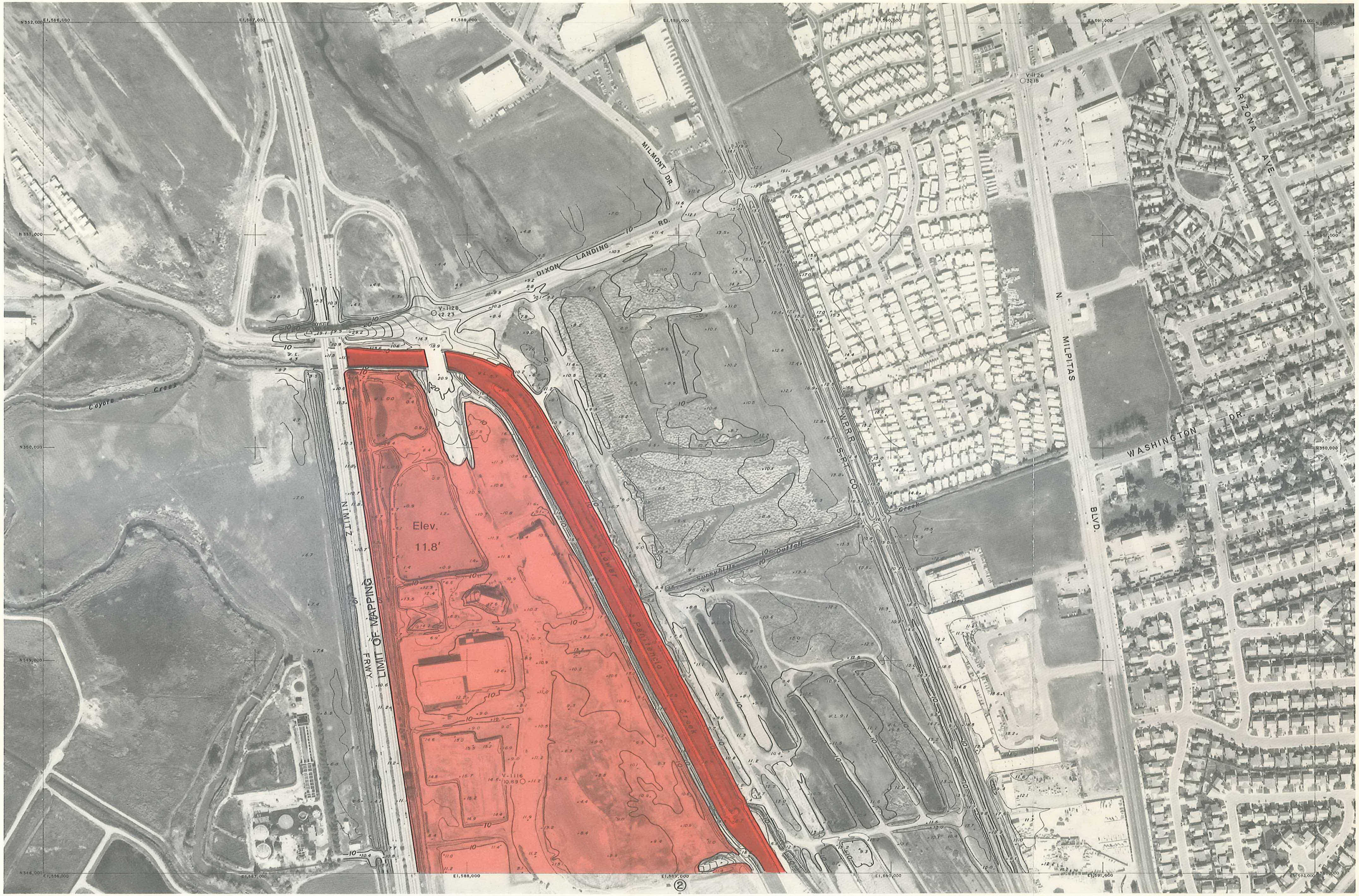
N

INDEX

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY

FLOODPLAIN MAPPING

Index



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

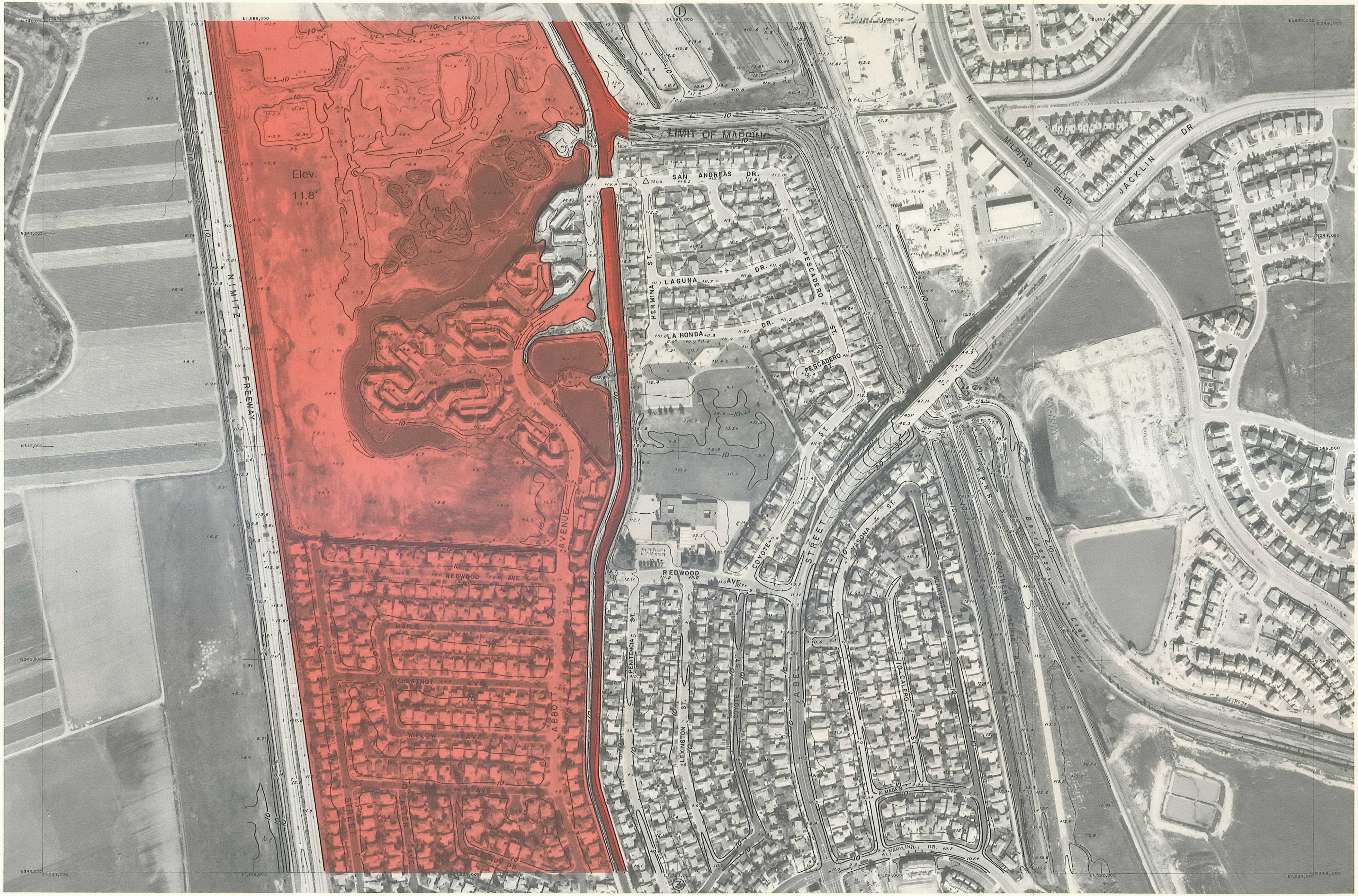
Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
LOW FLOW CHANNEL
2' FLOODWATER DEPTH
141' SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK FLOODPLAIN MANAGEMENT STUDY

FLOODPLAIN MAPPING

SHEET
1



Photogrametric Base Map Prepared by:
Aero–Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

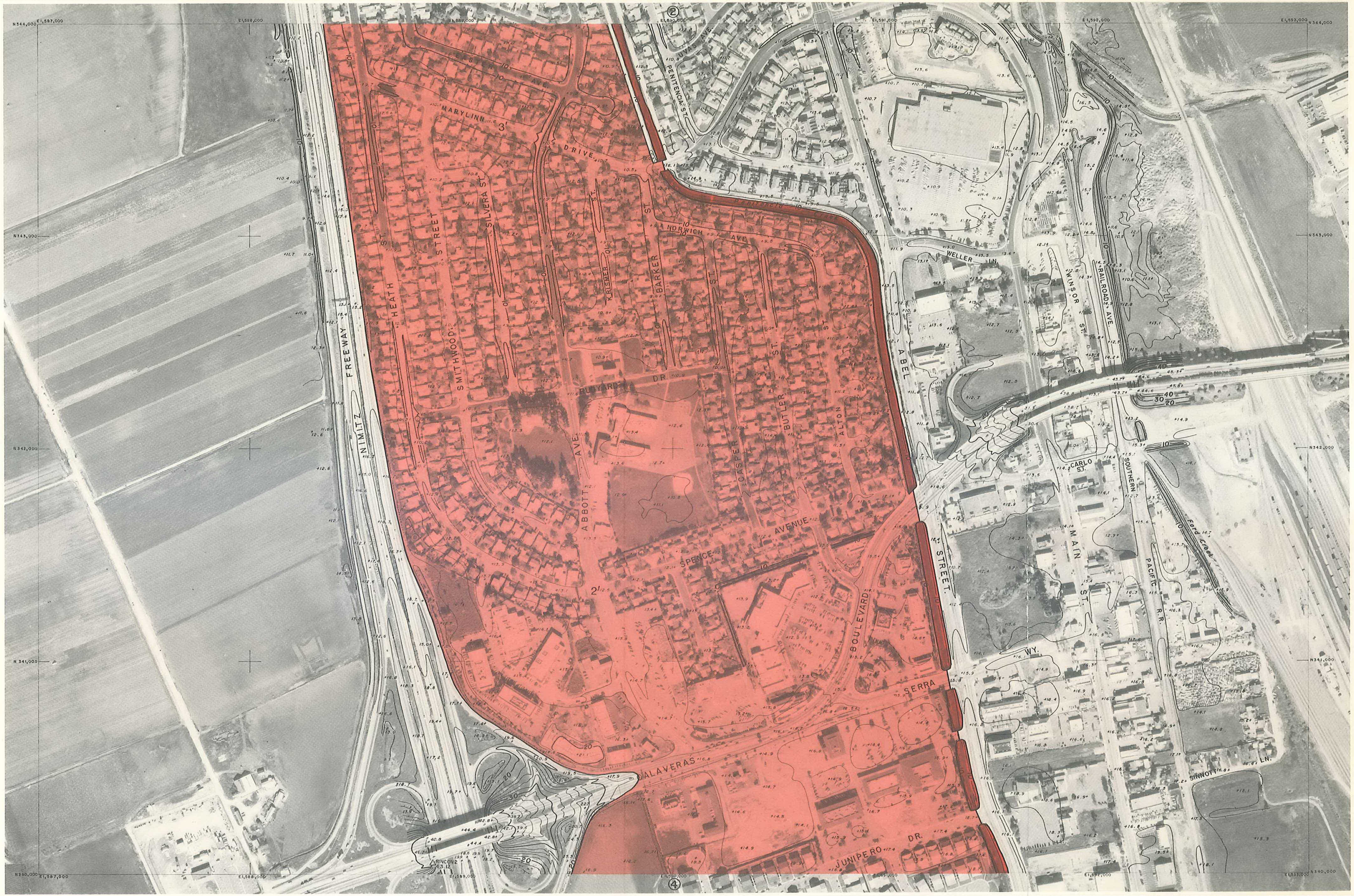
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

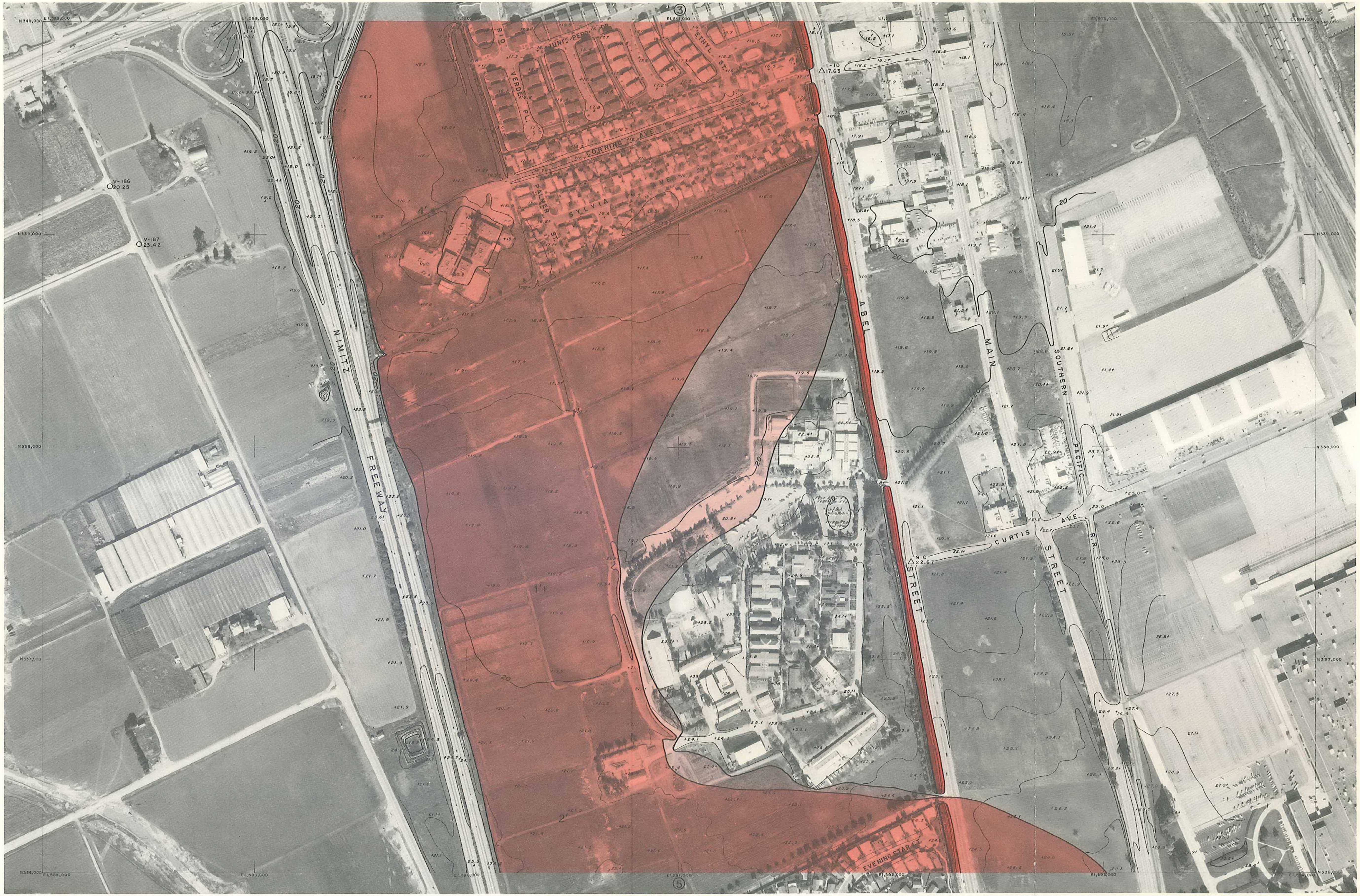
LEGEND:
LOW FLOW CHANNEL
2' FLOODWATER DEPTH
141' SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
2



Photogrametric Base Map Prepared by: Aero-Geodetic Corporation DATE OF PHOTOGRAPHY 1-17-84 FOR: Santa Clara Valley Water District	Floodplain Maps Prepared by: U.S. Department of Agriculture Soil Conservation Service January 1985	Scale: FEET 0 50 100 200 300 500 700 0 25 50 100 150 250 METERS N	LEGEND: LOW FLOW CHANNEL 2' FLOODWATER DEPTH 141' SPOT ELEVATION 10 YEAR 100 YEAR 500 YEAR	UPPER PENITENCIA CREEK FLOODPLAIN MANAGEMENT STUDY **FLOODPLAIN MAPPING**	SHEET 3



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

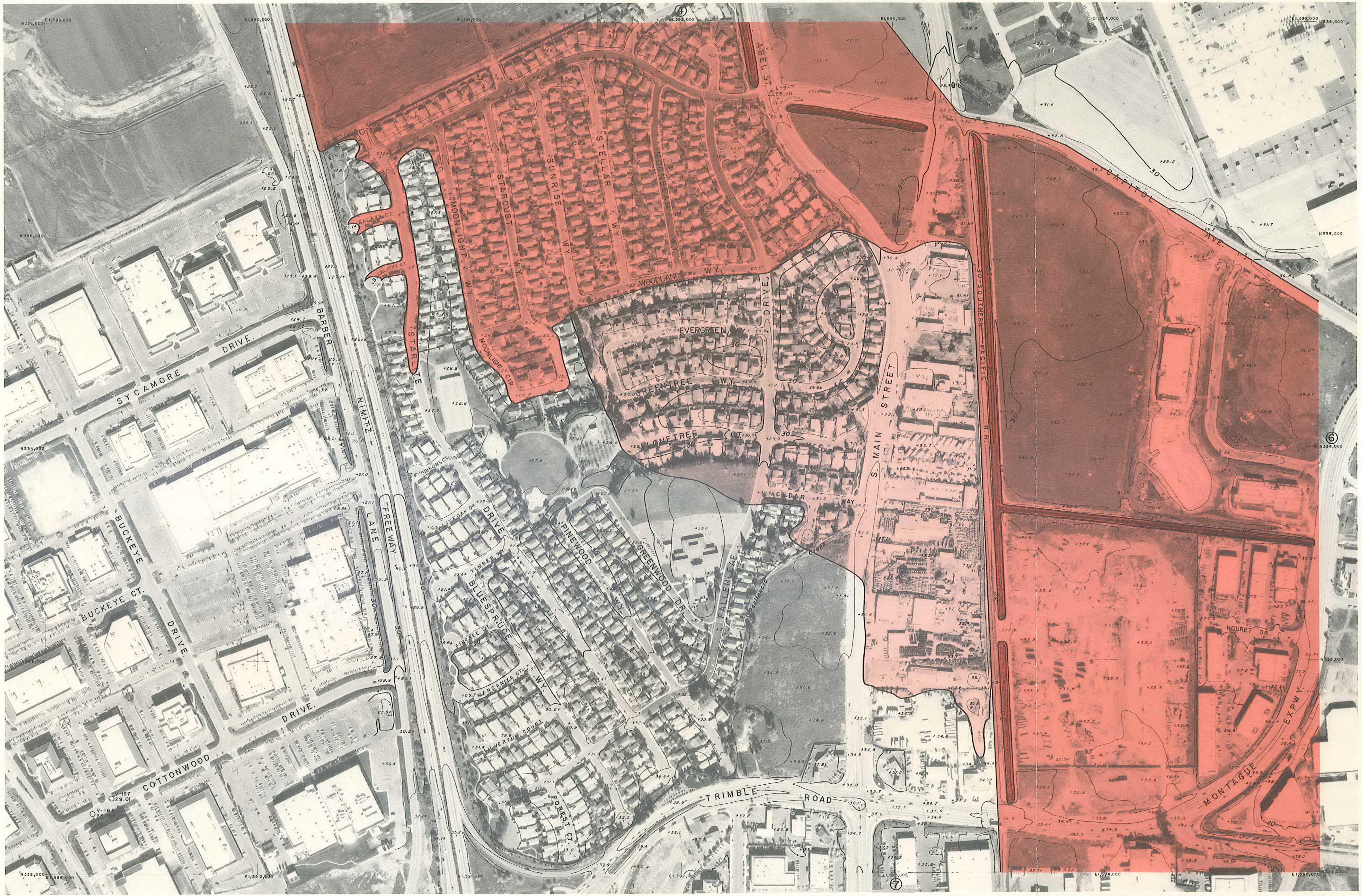
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
N
0 25 50 100 150 250
METERS

LEGEND:
LOW FLOW CHANNEL
2' FLOODWATER DEPTH
141' SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
4



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

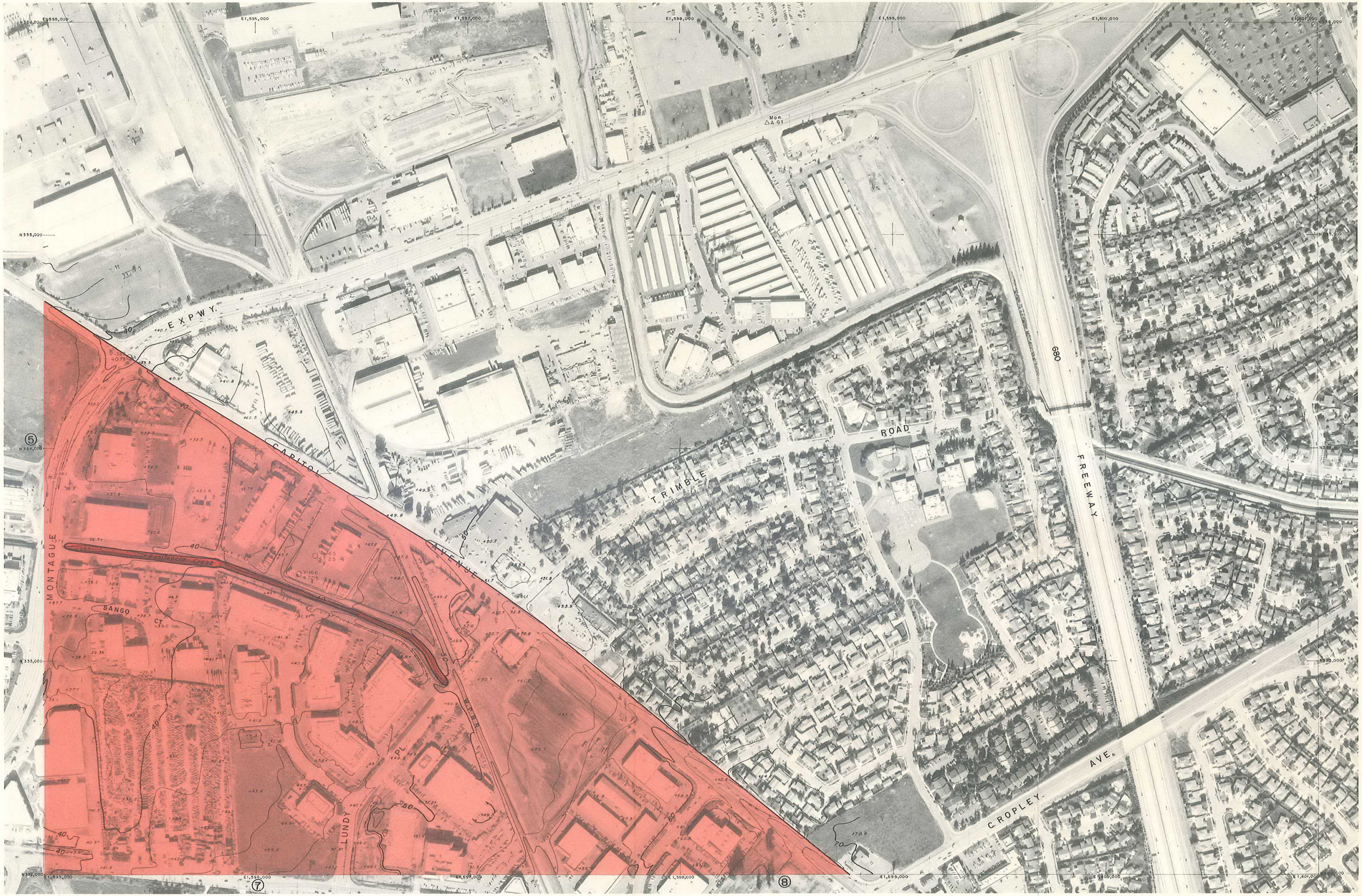
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
LOW FLOW CHANNEL
2' FLOODWATER DEPTH
141' SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
5



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

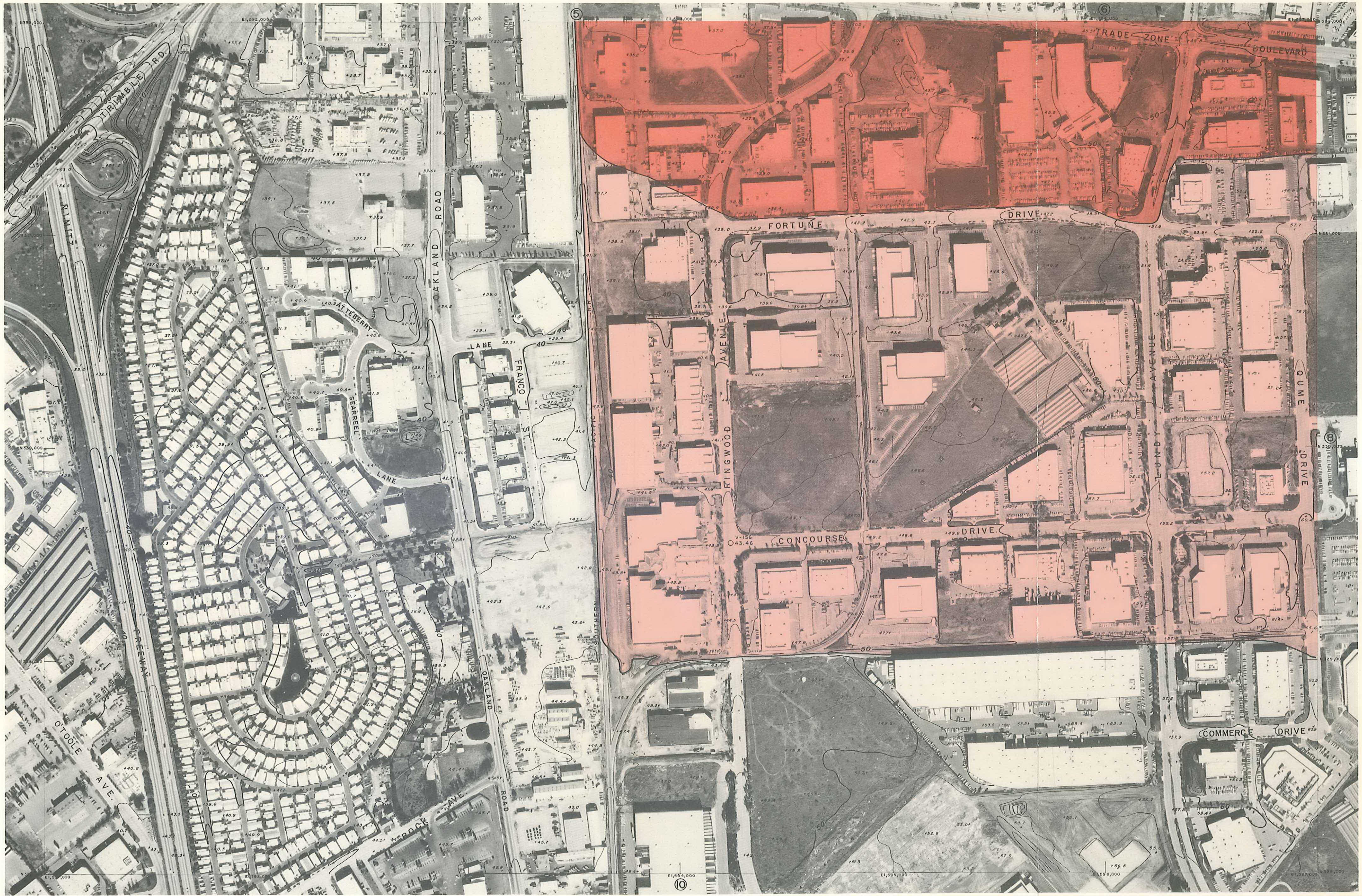
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
- ···—··· LOW FLOW CHANNEL
- 2′ FLOODWATER DEPTH
- 141′ SPOT ELEVATION
- 10 YEAR
- 100 YEAR
- 500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
6



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

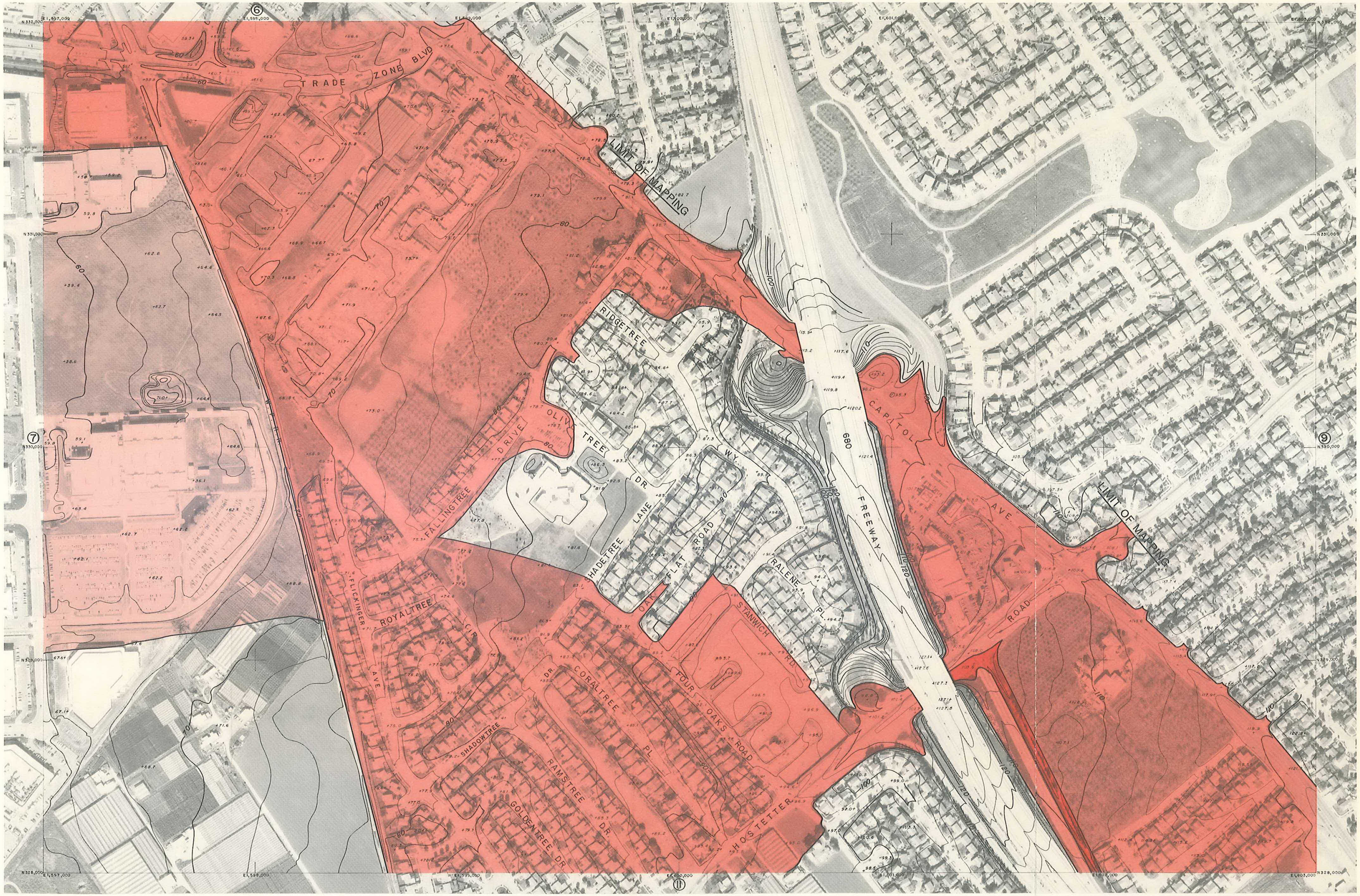
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
LOW FLOW CHANNEL
2′ FLOODWATER DEPTH
141′ SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
7

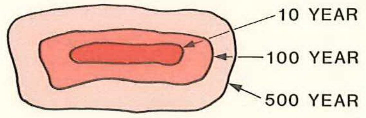


Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

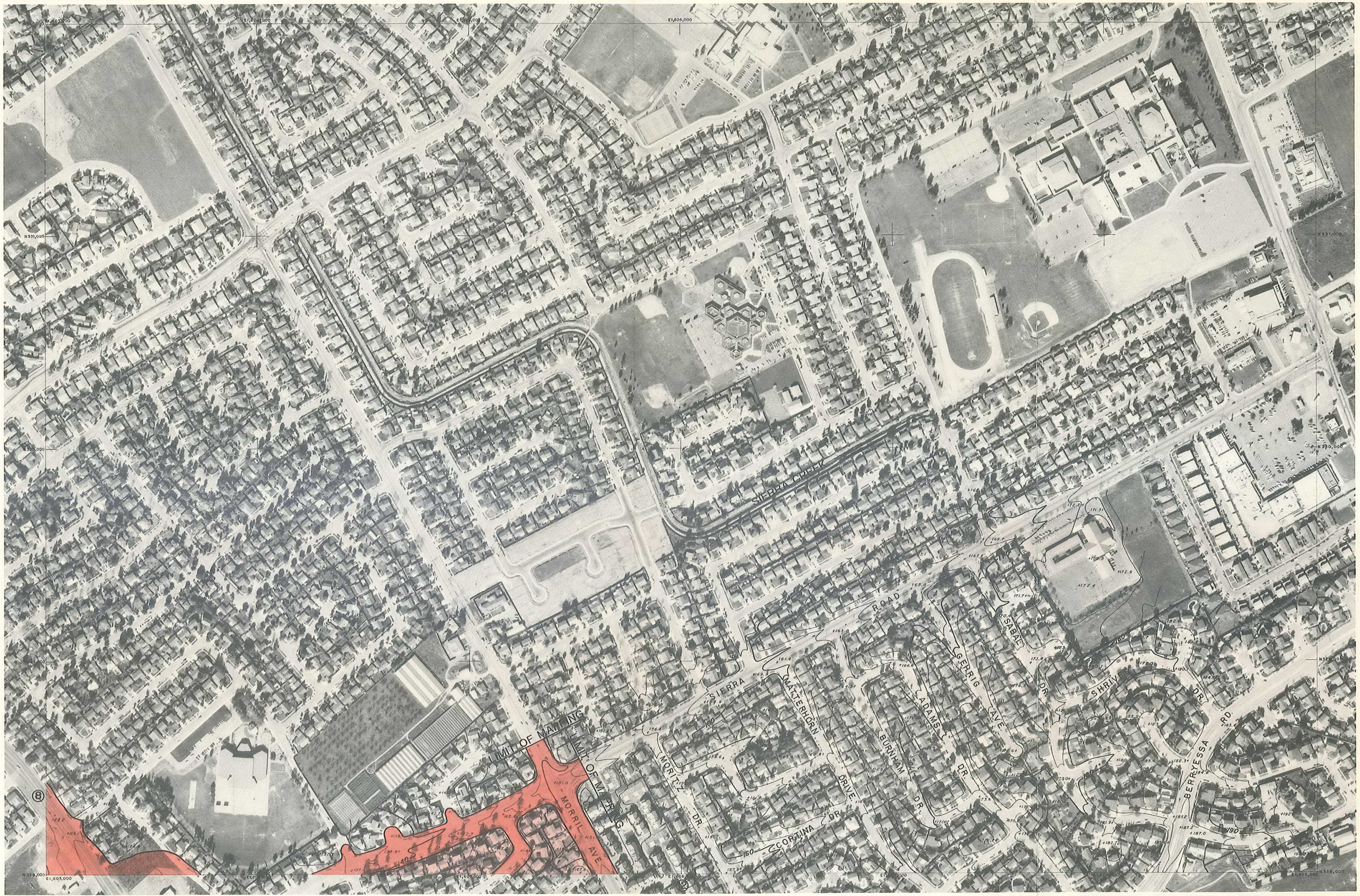
LEGEND:
LOW FLOW CHANNEL
2′ FLOODWATER DEPTH
141′ SPOT ELEVATION



UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY

FLOODPLAIN MAPPING

SHEET
8



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

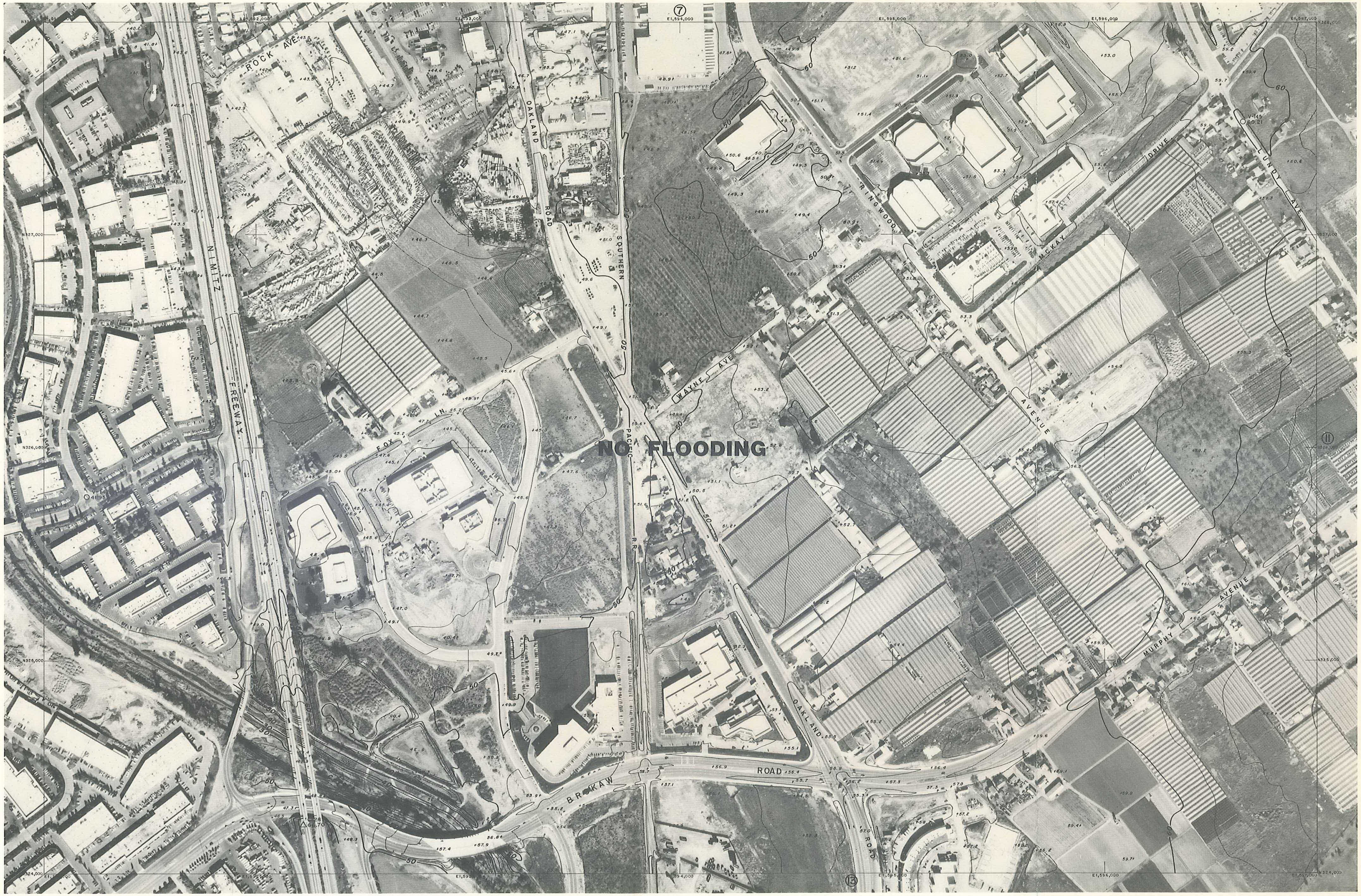
Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
- LOW FLOW CHANNEL
- 2′ FLOODWATER DEPTH
- 141′ SPOT ELEVATION
- 10 YEAR
- 100 YEAR
- 500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY

FLOODPLAIN MAPPING

SHEET
9



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

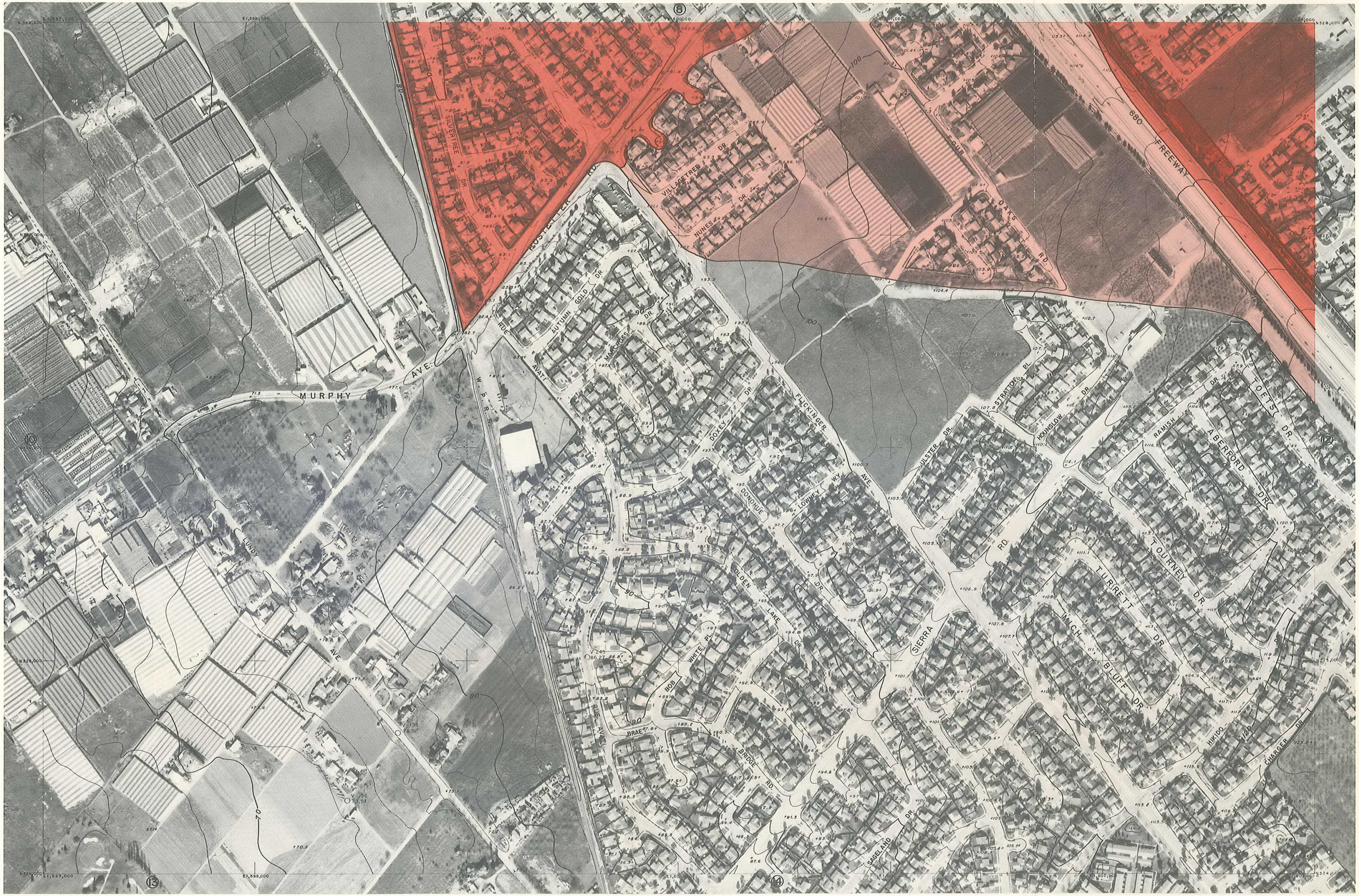
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
- LOW FLOW CHANNEL
- 2′ FLOODWATER DEPTH
- 141′ SPOT ELEVATION
- 🟥 10 YEAR
- 100 YEAR
- 500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
10



Photogrametric Base Map Prepared by:
Aero–Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

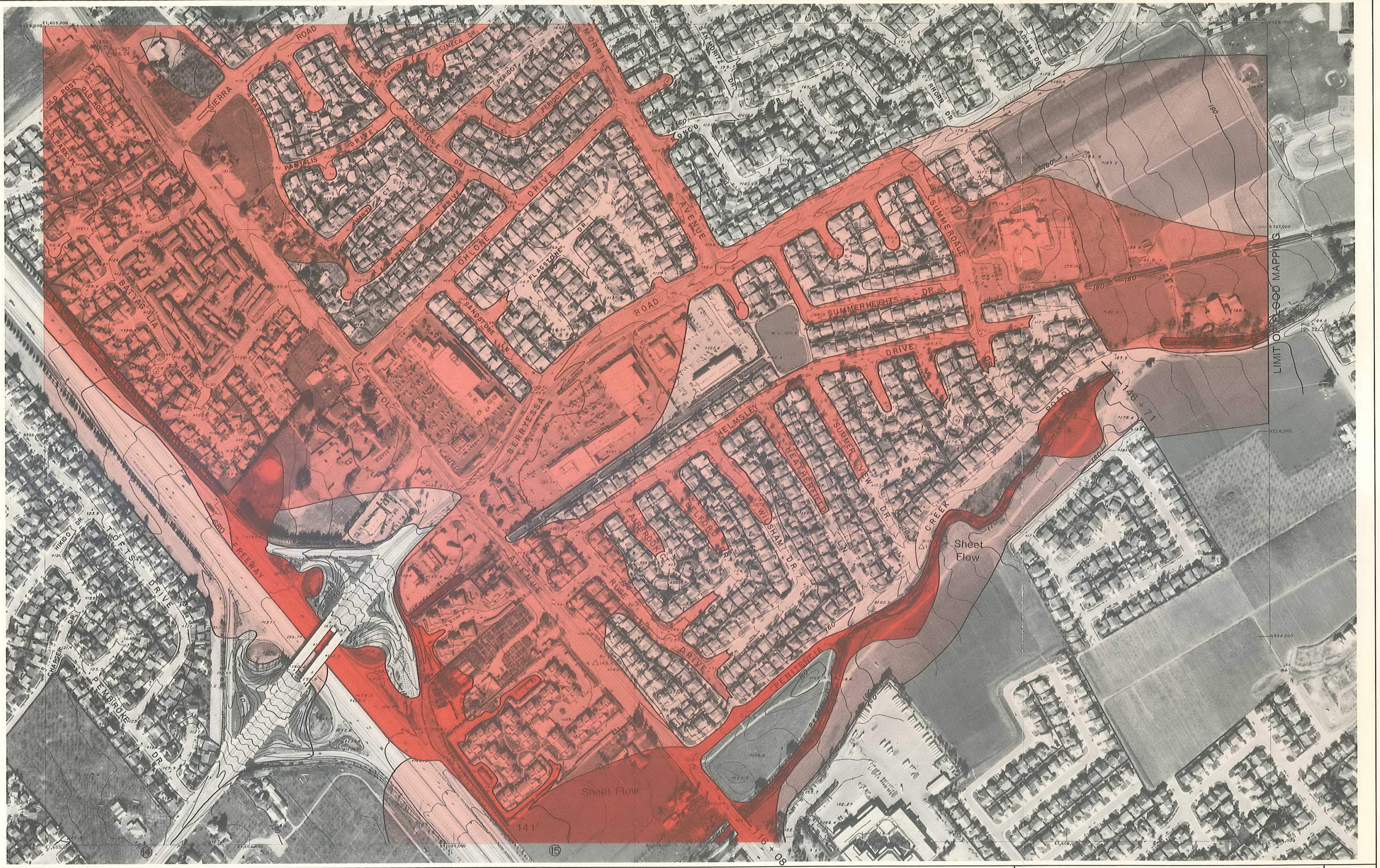
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
LOW FLOW CHANNEL
2′ FLOODWATER DEPTH
141′ SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
11



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

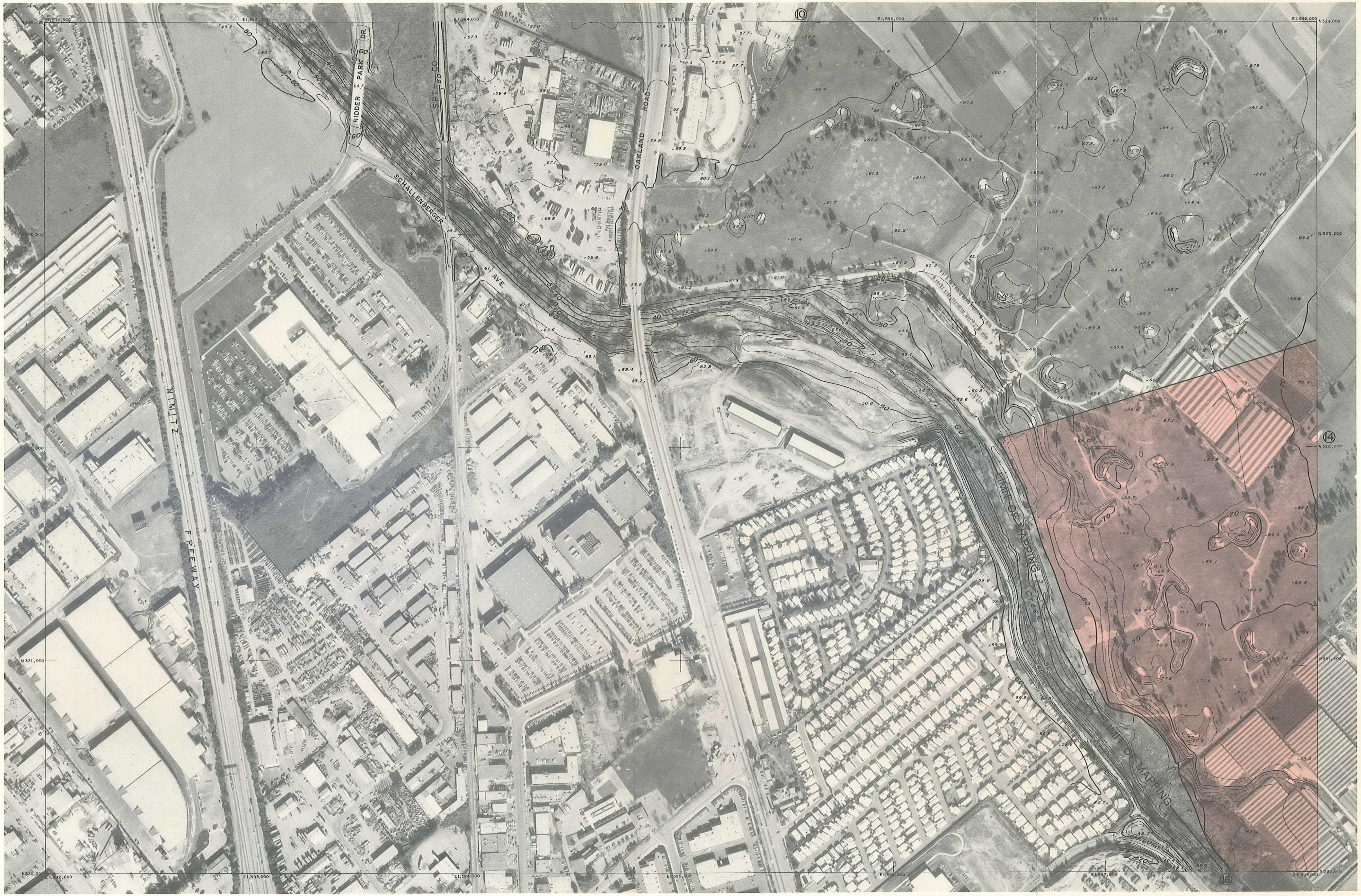
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
.... LOW FLOW CHANNEL
2' FLOODWATER DEPTH
141' SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
12



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

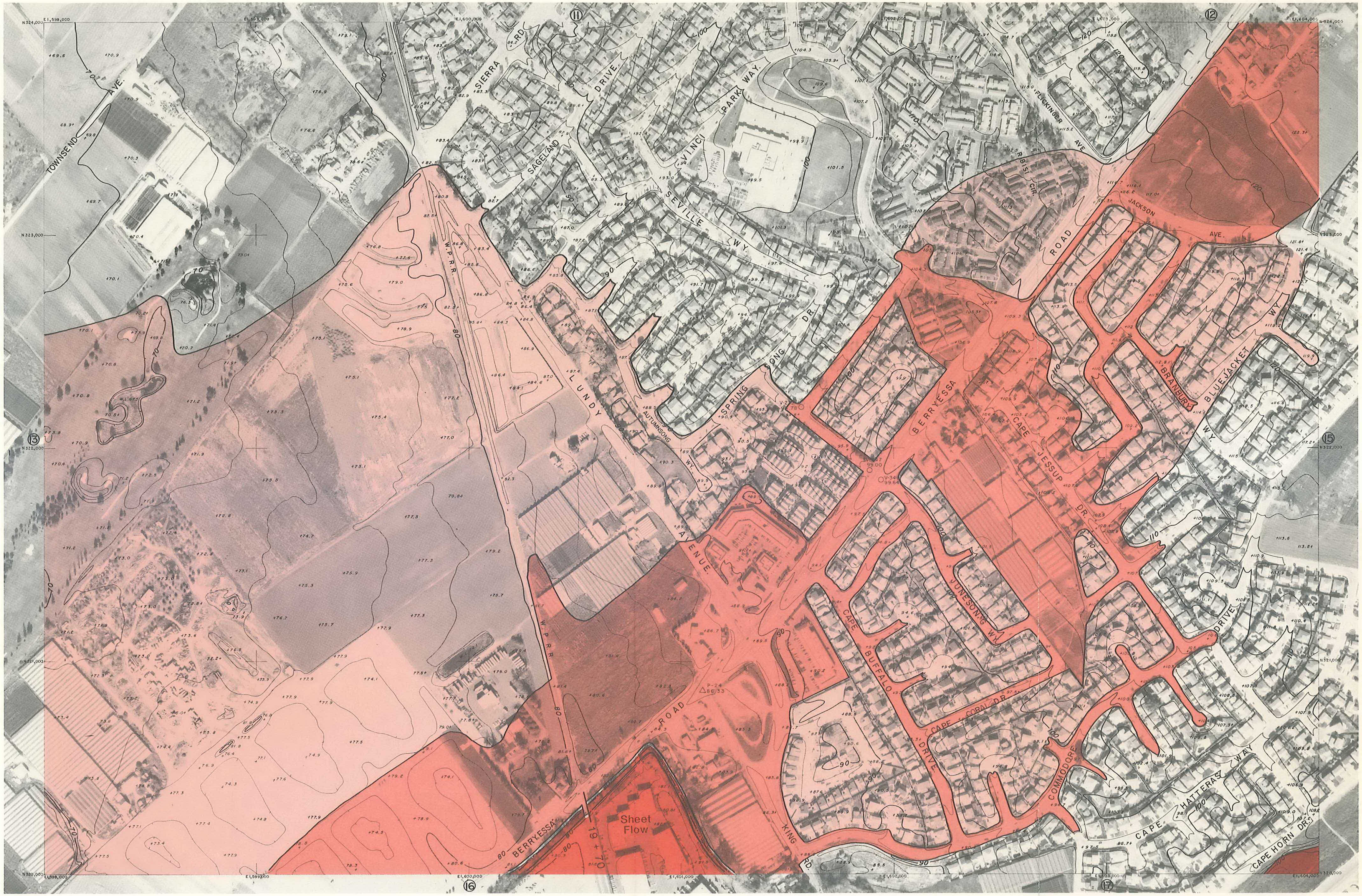
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
LOW FLOW CHANNEL
2′ FLOODWATER DEPTH
141′ SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
13



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

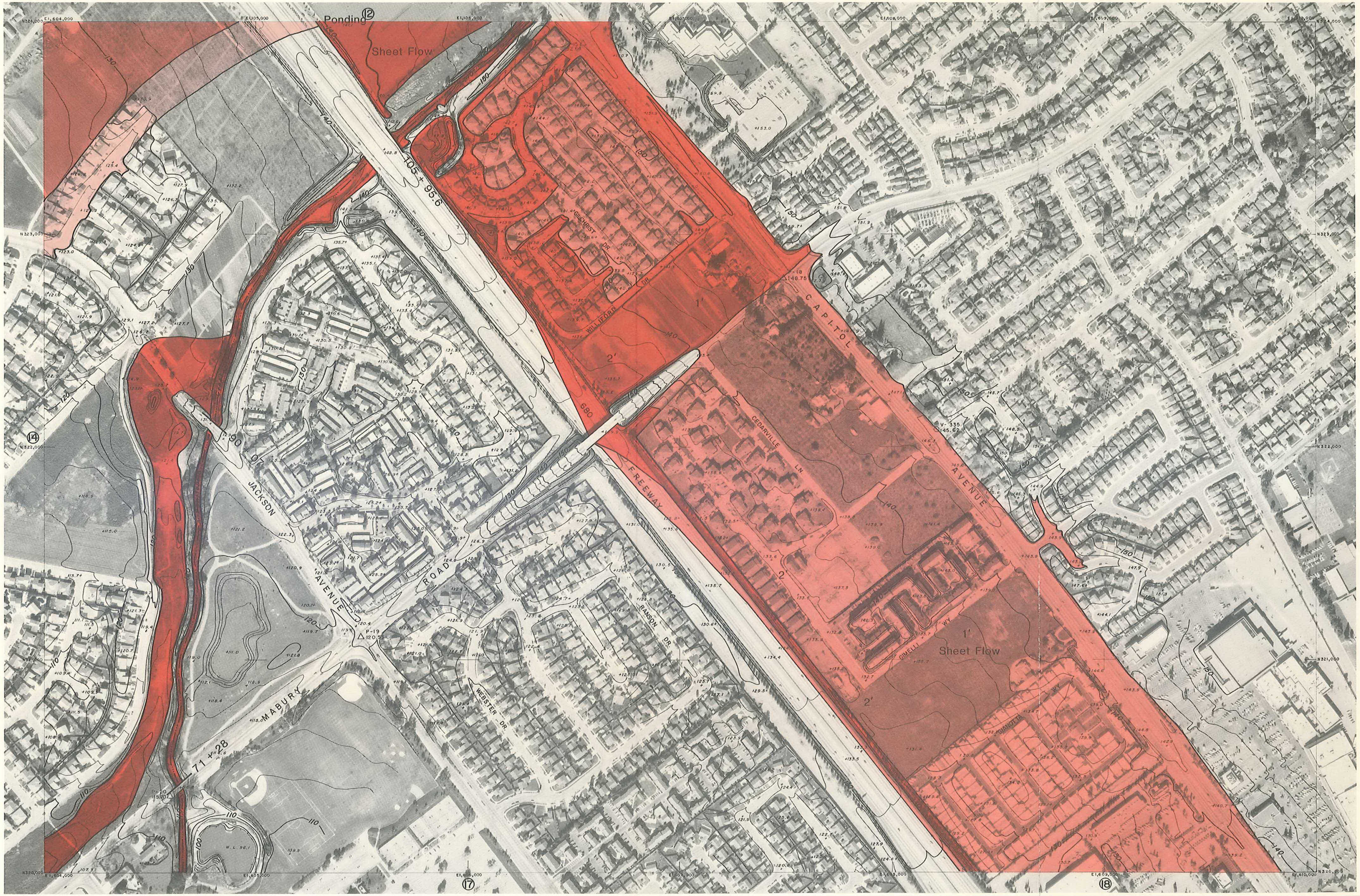
Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
-.-.-.. LOW FLOW CHANNEL
2′ FLOODWATER DEPTH
141′ SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY

FLOODPLAIN MAPPING

SHEET
14



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

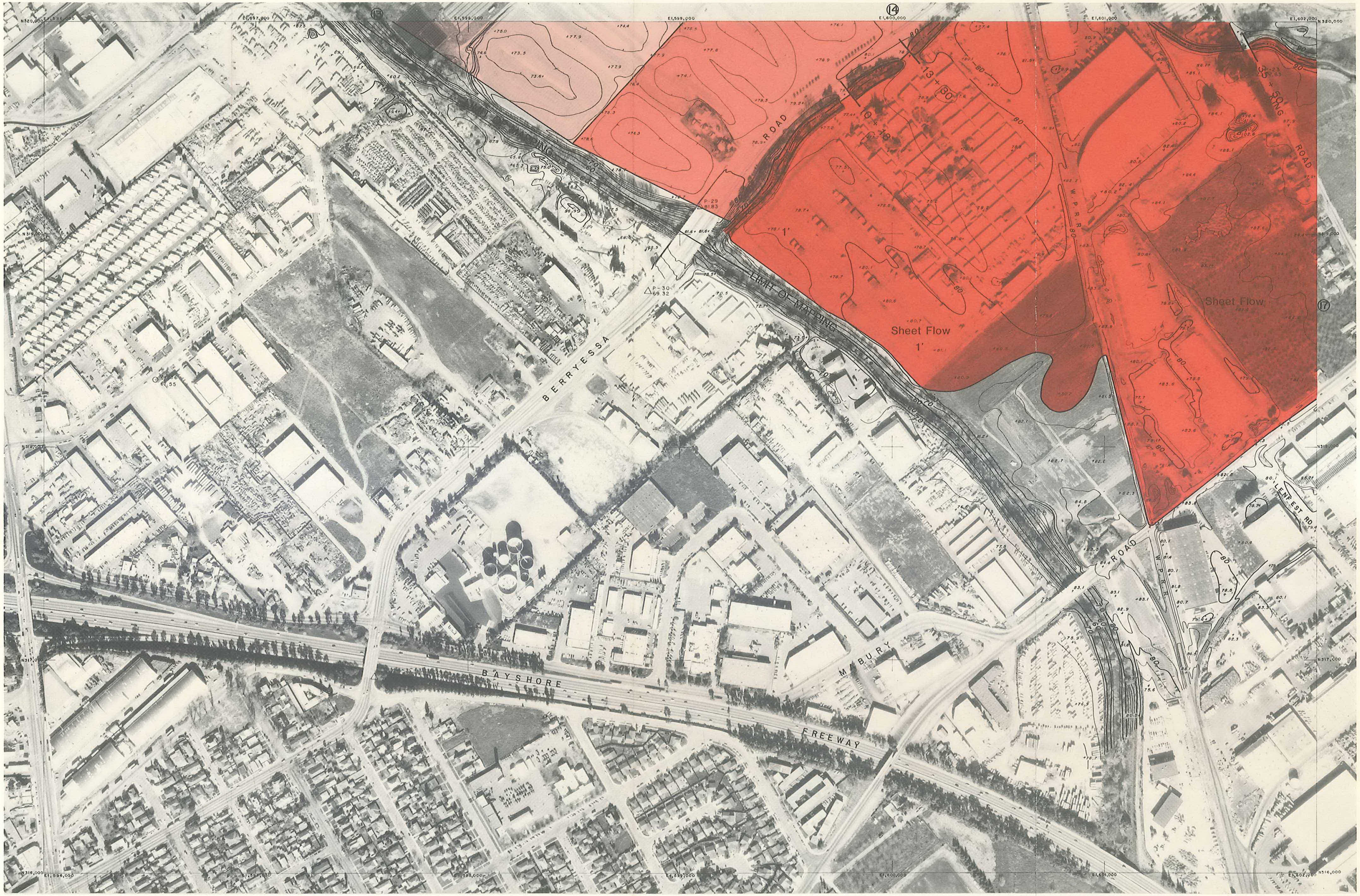
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
LOW FLOW CHANNEL
2' FLOODWATER DEPTH
141' SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
15



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

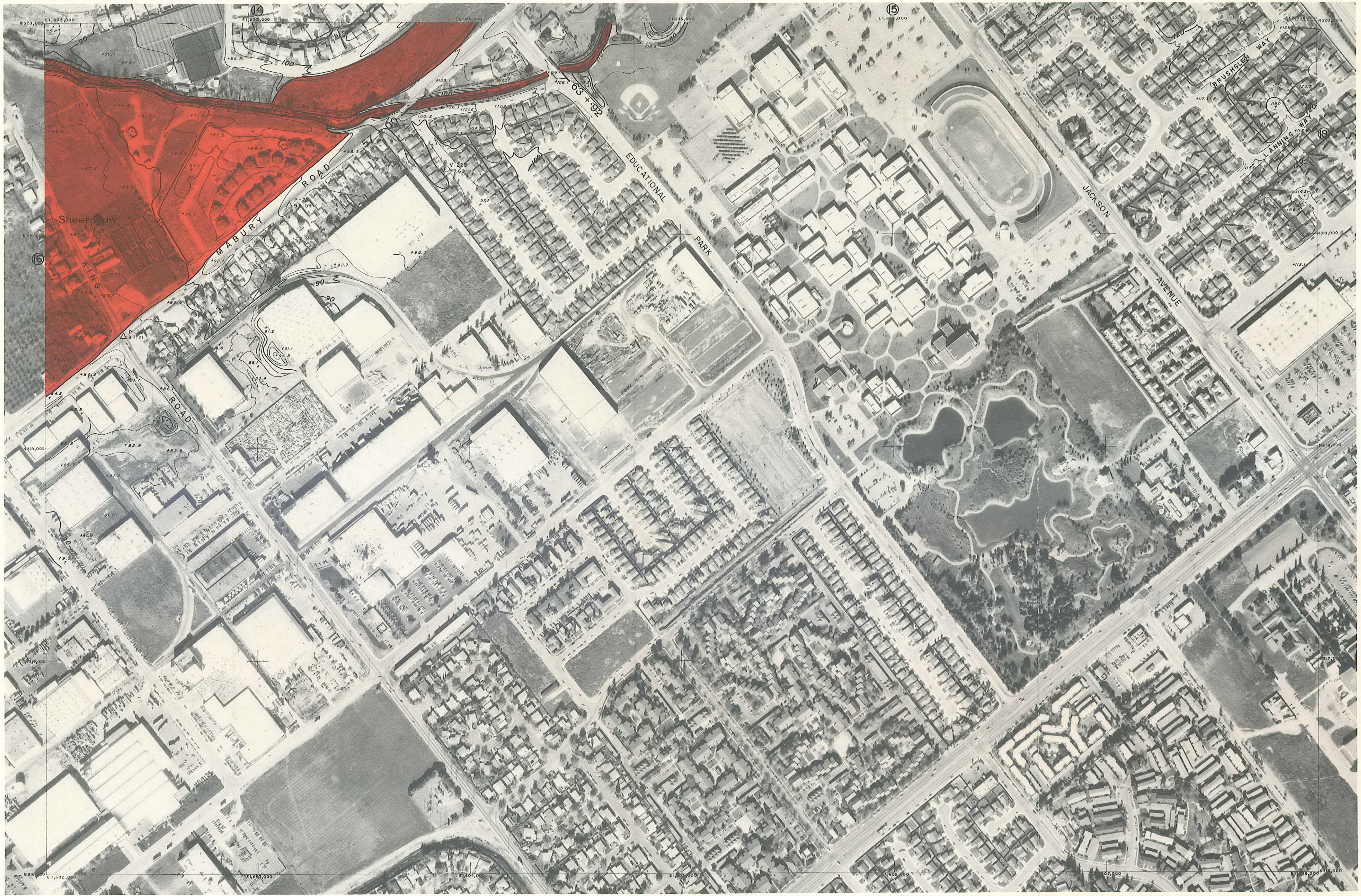
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
LOW FLOW CHANNEL
2' FLOODWATER DEPTH
141' SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
16



Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

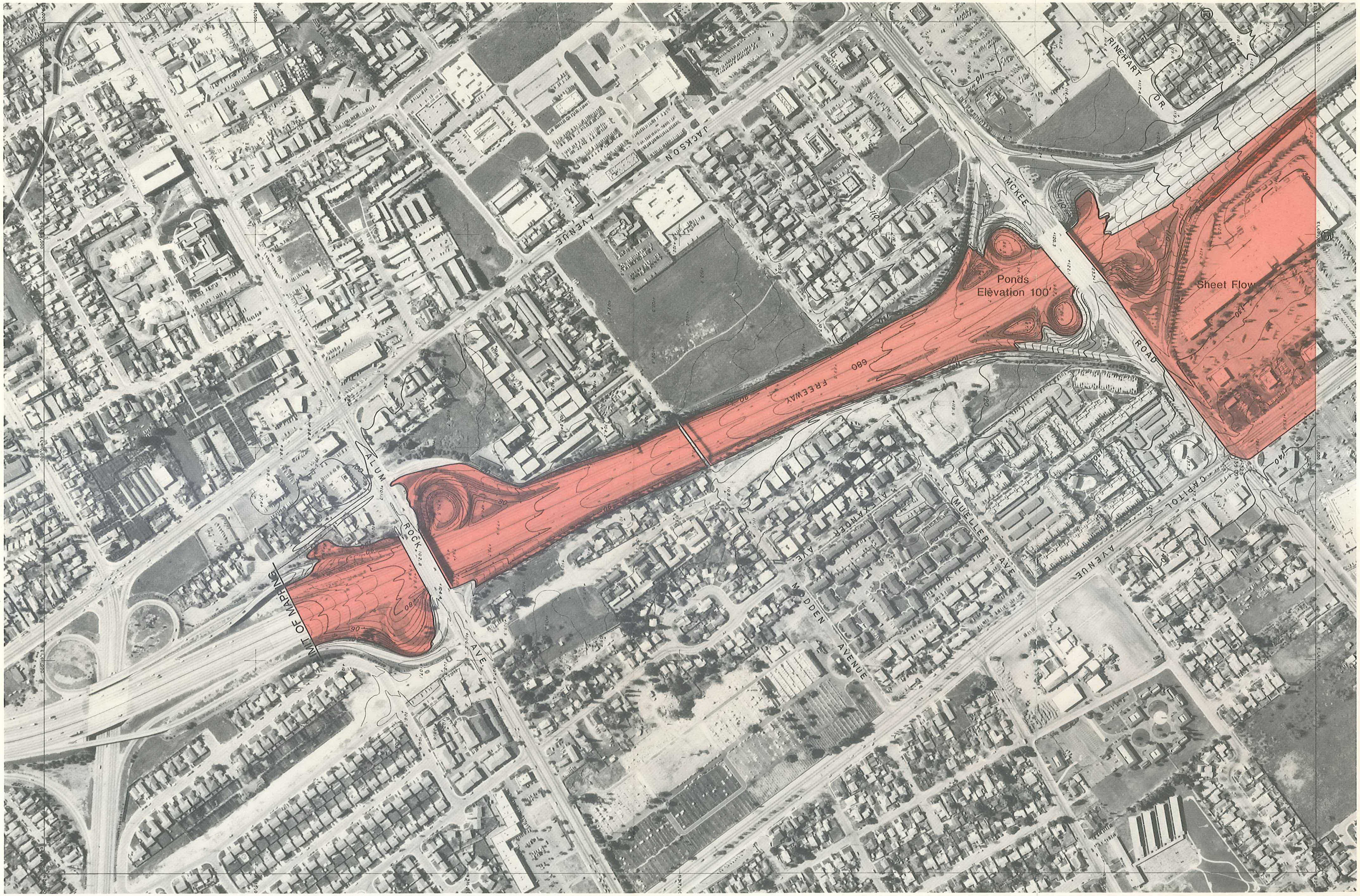
Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
N
0 25 50 100 150 250
METERS

LEGEND:
LOW FLOW CHANNEL
2′ FLOODWATER DEPTH
141′ SPOT ELEVATION
10 YEAR
100 YEAR
500 YEAR

UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY
FLOODPLAIN MAPPING

SHEET
17

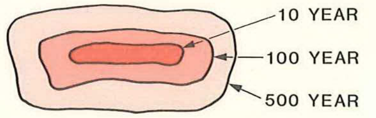


Photogrametric Base Map Prepared by:
Aero-Geodetic Corporation
DATE OF PHOTOGRAPHY 1-17-84
FOR:
Santa Clara Valley Water District

Floodplain Maps Prepared by:
U.S. Department of Agriculture
Soil Conservation Service
January 1985

Scale:
FEET
0 50 100 200 300 500 700
0 25 50 100 150 250
METERS
N

LEGEND:
LOW FLOW CHANNEL
2' FLOODWATER DEPTH
141' SPOT ELEVATION



UPPER PENITENCIA CREEK
FLOODPLAIN MANAGEMENT STUDY

FLOODPLAIN MAPPING

SHEET
18

SANTA CLARA
VALLEY WATER DISTRICT

85 APR 5 P1:53